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*Glennville*

**HARRY AND LUCY**

**CONCLUDED.**

**LONDON:**  
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# HARRY AND LUCY

CONCLUDED;

BEING THE

LAST PART OF EARLY LESSONS.

BY

MARIA EDGEWORTH.

IN FOUR VOLUMES.

VOL. III.

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The business of Education, in respect of knowledge, is not, as I think, to perfect a learner in all or any one of the sciences; but to give his mind that disposition, and those habits, that may enable him to attain any part of knowledge he shall stand in need of in the future course of his life.

LOCKE.

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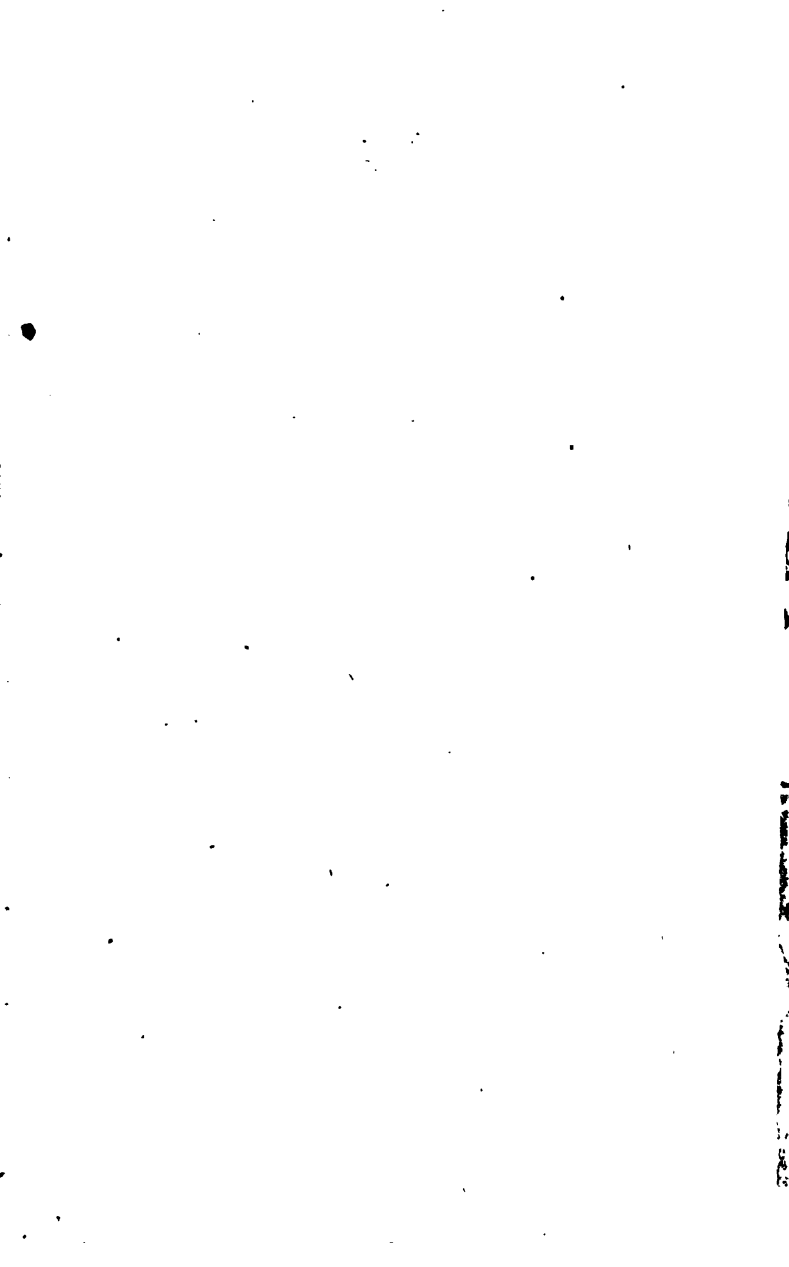
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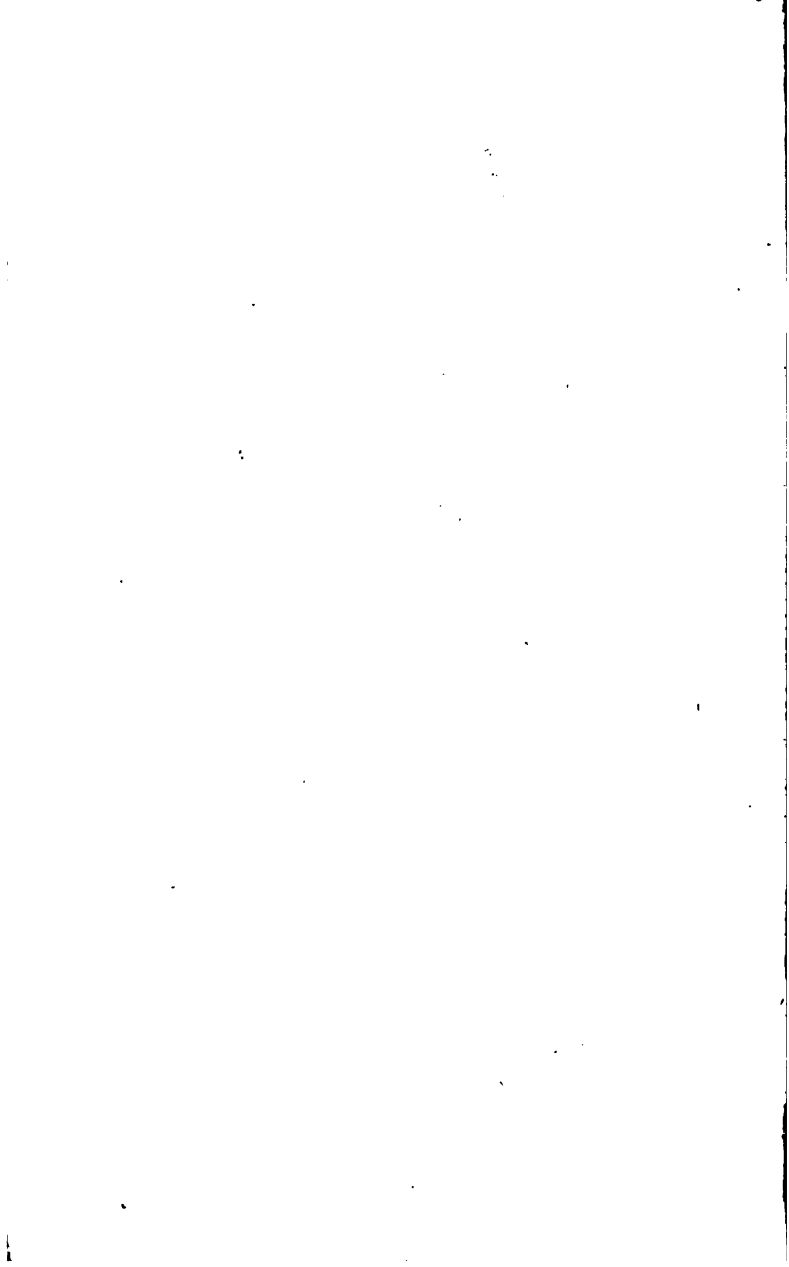
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*Glenn Miller*

**HARRY AND LUCY**

**CONCLUDED.**

where. I thought the cottage was to be on the sea shore."

And so it was, but the sea was hidden from the view of the windows of the house by a sand bank, which had been thrown up by the tide, and which was now covered by a plantation of evergreens. Harry persuaded Lucy to put off unpacking their trunk till morning, and to go out with him in search of the sea. He led the way, and as they went round the little lawn, she, delighted with the new place, and with every new flower and shrub, would have often stopped to admire. "Oh, Harry, look at this myrtle, taller than I am! Oh, Harry, this myrtle, taller than mamma!"

Harry looked back, but ran on to find the way down to the sea shore. "This is the way, this is the way!" he shouted joyously to Lucy, bidding her, "Follow! follow! follow!"

But suddenly he stopped, and was silent, struck by the first sight of the ocean. Lucy followed, and turning abruptly the corner of the rock which had hid the

view from her, exclaimed, "The sea! the sea!"

She stood for some moments in silence, beside her brother, looking at the vast extent of water, far as her sight could reach, bounded only by the sky. They were now standing on the sands of the shore. It was a still evening, the tide was ebbing, the sun setting, and there was a long bright light upon the water; while the green and white waves, curling gently over each other, moved on continually.

"How beautiful it is!" exclaimed Lucy. "How grand! Harry, is not it more beautiful and grander than you expected? Is not it, Harry?"

"Infinitely," said Harry. "But hush, I want to look, and to listen to it."

Lucy stood beside her brother a little while longer, and then ran back to the house to call her mother to look at it, before the red sun should be quite set. Her mother came, and they found Harry still on the same spot, fixed in admiration. His

mother seemed to know what he felt and thought, and to sympathise with him just as he wished. At first in silence, then expressing for him in words, that for which he could not find utterance. The ideas of boundless extent, duration, power; the feelings of admiration, astonishment, and awe, which create the sense of the sublime. While his soul was under this strong impression, his mother seized the proper moment to raise his thoughts still higher, from the ideas of immeasurable extent, duration, and power, to that Power by which the ocean, the sun, the earth, and we ourselves were created, and are preserved.

The impression made on the minds of Harry and Lucy was never effaced.

By sunrise next morning, Harry was on the sea shore. At the stated hours he was constantly there to watch the coming in and going out of the tide. This regular ebbing and flowing of the sea excited such astonishment in his mind, that it seemed insatiable. A fisherman, who lived by the

sea side, asked him if he had never before heard of the coming in and going out of the tide every day.

"Yes, I had *heard* of it, but I never *saw* it before," said Harry. That was quite another thing.

The sea and the tides took such possession of his imagination, that he could think of nothing else, not even of steam boats or steam engines. During the first day, he did not even think of crossing the sea in a steam vessel: he was completely absorbed in viewing this great spectacle of nature, and in considering its wonderful phenomena.

His mother was surprised to find that he was susceptible of this kind of enthusiasm, of which she had not till now seen in him any symptom. All his enthusiasm had seemed to be for mechanics; his mind had, indeed, opened during his travels to other objects, but still these had been introduced, or had interested him by their connection with the steam engine, to which



he had traced every thing good or great. So that, as she had once told his father, she was afraid that Harry's head would be quite turned by his dear steam engine, or at best that it would leave no room in his imagination for the beauties of nature, or for any thing else. But his father had answered, that there was no danger in letting the boy's enthusiasm take its course, especially as it was a means of collecting all the knowledge he could upon one subject. His father said, it was of little consequence to which science he first turned his attention; the same thirst for knowledge, when satisfied on one point, would turn to new objects. The boy, who was capable of feeling such admiration for the ingenious works of art, could not fail, as he thought, to admire with still greater enthusiasm the beauties of nature. He would have probably disliked them if they had been pressed upon his attention, and yet he would have felt pain from not being able to sympathise with the admiration of

his friends. His father was justified in his opinion, and his mother was now quite satisfied.

But on the evening of the day after their arrival, Lucy came to Harry with no face of rejoicing.

"Oh! my dear Harry, here you are standing on the sea shore, looking at the tide very happily; but you do not know what a misfortune has happened to you."

"What misfortune can have happened to me without my knowing it?" said Harry.

"I have been unpacking our trunk," said Lucy.

"The glass of my camera obscura is broken, I suppose," said Harry.

"You *suppose*, so calmly!" cried Lucy.

"Perhaps it can be mended," said Harry.

"Impossible!" said Lucy: "come and look at it, my dear Harry, it is broken into a hundred pieces."

"Then there is no use in looking at the hundred pieces," said Harry.

"But if you will come in and look at it," said Lucy, "I can show you just how it happened."

"I cannot help it now," said Harry, "so it does not much signify to me how it happened. I will look at it when I go in, but I want to stay here just to see how high the waves come at full tide."

"I am glad your head is so full of the tide, Harry," said Lucy; "I was afraid that you would be excessively vexed, as I was when I opened the box and saw it. Besides, I was afraid that you would think it was my fault."

"No, I could not be so unjust," said Harry. "I remember how carefully you packed it, and how good-natured you were about it; and I do not forget your shell box, which you left at home to make room for my camera obscura. Now I am sorry you did not bring it."

"I can do without it," said Lucy.

"I will make a shell box for you," cried Harry; "and I know how I can make it, out of that camera obscura of mine, and

without spoiling it, even if I should get a new glass. I will go in and look at it, and begin directly," said Harry. "I mean as soon as ever I have seen the tide come in, and marked how high it comes up on this rock."

Withinside of the box of Harry's camera obscura there was a set of hinged flaps, which lay at the bottom, when it was not used, but which, when it was to be used as a camera obscura, were lifted up, and, joining together, formed a sort of pyramid, on the top of which the eye glass was fixed. This glass being broken, Harry cleared away the fragments, and took out the pins from the hinges of the flaps which formed the pyramid. Then he could take out the flaps, and these with their pins and hinges he gave into Lucy's charge to take care of till they should be wanted again. Then with the help of an old knife, the only tool to be had in Rupert's cottage, he cut up a blue bandbox, the only pasteboard to be had in Rupert's cottage; he carved and cut this pasteboard into a number of slips

with tolerably straight edges, and these were to be fastened inside of his box at the bottom, so as to form divisions from the middle, in the shape of a large star ; the corners round it filled up with other divisions of hearts and crescents, with some, as Lucy described them, of no particular shape. This was the ground plan, these divisions were but half the height of the depth of the box : over this first story, there was to be another, a tray was to be made to fit in, and to lie on the top of the *basement* story, as Harry would have it called. With difficulty the blue bandbox furnished sufficient pasteboard for this. Every scrap was required, and some parts of its rim had been so much bent, and bruised, and battered, that they could scarcely be made fit for service, with Harry's utmost care and skill. When the work was all cut out, Harry set Lucy to write numbers on the pieces of the stars, hearts, crescents, and nondescripts, that each might fit rightly into its place. This he had learned, he said, from reading the description of the building of the Ed-

dystone lighthouse. It was a precaution he found of great use in the present work, the first of the kind he had ever attempted. He had no glue. The cook, or she who acted as cook in Rupert's cottage, had no time to make paste. Harry, however, searched in the orchard on the cherry trees for gum, and found some, which he melted in hot water. It was too thin, so thin, that it would not stick his divisions together. By his mother's advice, he melted it in vinegar, with which he made an excellent cement. Though his fingers were unused to this fiddle-faddle work, as he thought it, he persevered for Lucy's sake, and for the sake of his promise. It was difficult to make the tray fit rightly, or draw up and let down easily; but he polished away all friction at the four corners, and he fastened tapes to the middle of each of the four sides so judgmatically, that it could be drawn up without hitching, and without danger that when filled to the brim, with the smallest of sugar-plum-

sized shells, it should overturn or be overturned.

While Harry had been working at the shell tray in his own little room, Lucy's head was in all the cares and joys of arranging his goods and her own, after the general unpacking. It not only required nice arrangement to make things comfortable in the small space allotted to them in their new abode; but continual care would be necessary to keep them so; and now Lucy felt particularly the advantage of those habits of order which her mother had taught her, even when she was a very little girl.

"Lucy, put your work into your work bag, and put your work bag into its place," had not been said in vain.

When Lucy had arranged her own room, she stood contemplating her arrangements, and said to herself,

"What a pleasure there is in seeing all things fit nicely into their places."

This pleasure in the perception of the

fitness of things has been felt probably by every little or great lover of order, as well as by Lucy. Besides our sense of the convenience of having things in their places, and the expectation of finding them readily when wanted, we feel some self-approbation in having done our duty in putting them to rights.

Lucy having finished to the best of her power the arrangement of all her brother's things, and her own, went out to the sea shore to look for shells, and numbers she found. The whole day was spent in the delightful search, and the next morning, the moment breakfast was over, she asked Harry to come again with her to the same amusement; but he said, that he had business to do first, and that he would join her as soon as he had learned his lessons.

"Lessons!" repeated Lucy, with surprise, not unmixed with disappointment. "Do you intend to go on with lessons, Harry?"

"Yes; why not?"



"I do not know," answered Lucy, putting on her bonnet; "but I thought you need not learn them—I did not know that we were to go on with lessons now. We are not at home."

"We are at home now, I think," said Harry. "This is to be our home for two months at least."

"That is a long time to be sure," said Lucy, tying the strings of her bonnet, "but I have not settled to any thing yet; I have no Greek to learn, thank goodness! I will go down to the sea shore to day at least, and you will find me there, Harry, when you have done your business: make haste."

Harry with his books under his arm, and Lucy with her bonnet on, and shell tray in her hand, were turning their different ways in the matted passage, when their mother came out of her room.

"Where are you going, Lucy?"

"To the sea shore, mamma, to look for shells."

Her mother said, that this was a pleasant amusement, but reminded her that there were other more necessary employments.

“Yes, to-morrow, mamma, I intend —”

“Why not to-day, Lucy,” said her mother.

“I thought it would not signify, mamma, if I went without lessons one day more: you know I have not done any during all the journey. And in one day I could not learn much.”

“My dear Lucy,” said her mother, “when your father and I first thought of bringing you with us on this journey, we considered whether it would be of advantage or disadvantage to you.”

“Thank you, mamma, and you said yesterday, that you thought it had been already of great use to Harry.”

“True, my dear; but now, I am speaking of you.”

“Me only, mamma?” said Lucy. “When you said you, I thought you always meant both of us.”

"You are not quite so steady in perseverance as your brother; and I was afraid that seeing a great number of new things, and being with a number of new people, might be of disservice to you."

"But I hope you do not think I am spoilt at all yet, mamma," said Lucy.

"I cannot tell yet, my dear," said her mother, smiling, "that remains for you to show me. Your father thought, as he told me, that I might trust to the habits of regularly employing yourself, which you have lately acquired or resumed, and to the influence of your brother's example. I shall not have it in my power to attend to you here so much as I do at home. I must ride out while I am here some hours every day for my health, and I am to bathe, therefore I cannot be with you so much, or hear your lessons as I used to do at regular times."

"Never mind, my dear mother," said Lucy, "I will get them always regularly. You shall see, mamma, that papa was right in thinking you might trust to me, and I

will follow Harry's example; and I will begin to-day, and this minute," added she, untying her bonnet. "I will put by my shell tray. You will allow, mamma, that I am exact in putting by my things; and before I went away from you, mamma, I *was* regular in employing myself. I know that was the reason you said *resumed*. You shall see, mamma."

From this time forward, Lucy, at fixed hours, always went to her daily employments or lessons as punctually as Harry went to his, and performed them well, whether her mother had leisure to attend to her or not. Never did Lucy neglect or voluntarily omit any of them, one single day while they remained at the sea shore. And when it was all over she declared, that of all the pleasures, the many pleasures she enjoyed there, the reflection that she had done this was the greatest. Nothing is more tiresome than to spend all day long in amusement, or in trying to amuse oneself. Lucy, after working hard and well, at whatever she knew she ought to do, en-

joyed with double pleasure the succeeding hours by the sea shore. Harry, with complaisance which his lasting gratitude for the packing his camera obscura sustained, used to help her to pick up shells, but it was not an amusement particularly to his taste; and when he had stooped till his back ached, which soon happened, he went off to refresh himself at some of his own works. He had a bridge to build, and a canal to cut, and a lock to make. These were some of the projects which he had formed during the journey, and which he was now eager to carry into execution.

He found a fine place for his canal, between two rivulets, at some distance from each other. His little bark might sail triumphantly, for a length of course, if he could effect their junction. He levelled and calculated, and calculated and levelled, before he dug, with as much care, perhaps, as has been bestowed upon some great public works. He dug and excavated indefatigably. His method of proceeding was to keep the water back by a small

dam of earth till he had advanced a few feet; he would then remove the dam, and the water, which flowed in, detected any errors that he had committed in the level. When the cut, however, had been made some yards in length, the sides in many places fell in, for the soil was loose and crumbly. This misfortune was easily remedied by increasing the slope of the sides: but a more serious disaster befel our young engineer, which obliged him to recur to his father's never-failing advice. He had carried his work through a vein of sand, and though the sides had been properly sloped to keep them from falling in, yet when he opened the dam, and admitted a little water, it gradually disappeared, and left the canal dry.

His father willingly gave his assistance, and having examined the spot, and perceiving that the sand communicated with other porous ground underneath, he said, "This is a difficulty, my dear Harry, which often occurs to older and wiser engineers, and always occasions great increase of trouble

and expense. I was in hopes, that by some alteration in the line of your canal, this leaky place might have been avoided ; but the sand is so extensive, that I believe your only resource will be to *puddle* the sides and bottom."

He took Harry to a ditch, at some little distance, in which there was a bed of strong tenacious clay ; and he explained to him, that *puddling* was performed by spreading the clay in layers, wetting it sufficiently, and then beating it into a thick paste, which he would find was quite impervious to water. As soon as Harry knew what was to be done, he proceeded in his work with fresh vigour ; and Lucy assisted him in carrying the clay in small quantities, such as their only basket would hold. The clay-paste was well mixed and rammed with the butt-end of a long club, and the sides and bottom were nicely smoothed with the back of the spade. When the dam was again opened, the canal was tight and firm to admiration, and Harry felt not only the pleasure of successful

labour, but the satisfaction of having acquired knowledge in every step he took. Lucy stood by to witness and admire this operation, in which proper female consideration for her shoes and petticoats forbade her to join; but female sympathy is often agreeable, in circumstances in which woman's aid can in no other way be given. Something to this effect, but very unlike it in words, Harry once said to Lucy, and it paid her for standing above an hour looking on.

Harry had examined the real lock on the canal, and understood its construction so well, that he succeeded in making his miniature imitation. The canal about two feet wide, and one foot deep; the lock about four feet long from gate to gate. The gates were made of an old hatch door of the chicken yard, which he found, posts and all, among a heap of rubbish in the wood house. His father gave him leave to take possession of it, and the woodman lent him a saw, with which he cut it in two, across the middle, leaving on each half one of



the leather straps, which had served for hinges. He wisely contented himself with single gates at each end of his lock, as he was aware, that neither his skill nor his tools would enable him to construct the double gates which meet together angle-wise, so as to support each other, and which he well remembered was the case in the real lock. The posts he sawed in two also, in the middle of their height; but this he did without sufficient consideration; he spoiled his four well-seasoned posts, and lost a day by this rash act. He found each of them cut too short for the doors and sides of his lock, because he had not considered the depth to which it was necessary to drive them into the ground, to make them stand firmly, and bear the weight of the doors that hinged upon or shut against them. He had four new posts to make, and these he made twice as high as the others, and drove them down several inches deep into the ground. This was the hardest work of all. Harry, without hat or coat, wield-

ing the woodman's heavy axe, battered these piles with the butt end, lending his little soul at every stroke. At every pause Lucy in pity would say,

"Harry, pray do let me try now, while you rest yourself."

But when she took up the axe, she found it was too heavy for her, and her strokes were so feeble, that they did no good, the post never stirred at her hammering, never sunk, in twenty strokes, a hair's breadth. Each blow of hers was so uncertain in its aim, that Harry, fearing the axe would turn in her hands, and that she would end by cutting off her legs, besought her to desist, protesting that it made him hotter to see her batter than to batter himself. He assured her that battering was too hard work for women, and quite unfit for them, and she, being much out of breath, believed him, and resigned the ponderous axe. He worked himself into another heat, while she repeated many times,

"It will do now, Harry; it is deep

enough down now, Harry, I am sure; that is enough."

But Harry battered on till the post would stir no more, then he was satisfied, for it was, as he said, "*au refus de mouton*."

"*Au refus de mouton*," said Lucy, "what can that mean? Mouton is mutton or sheep. What can mutton or sheep have to do with this?"

Harry told her, that mouton is not only the name for mutton and sheep in French, but also for a battering hammer, or pile engine, the machine with which piles are driven down into the ground. He said, that he met with the expression in a description of the pile engine, which he had read in consequence of the old gentleman at Mr. Frankland's having excited his curiosity about it, by the description he gave of the houses in Amsterdam built on piles.

"How curious it is," said Lucy, "to see how one thing leads to another, and how one bit of knowledge, sometimes in the oddest way, helps us on to another that seems to have nothing to do with it. And,

Harry, think of your explaining this French expression to me, though I began to learn French so long before you, and though I heard so much of it, from French people too, when I was at aunt Pierrepoint's; I ought to be very much ashamed."

"Not at all, my dear," said Harry; "this is a scientific expression, not necessary for a woman to know."

Lucy looked as if she was not sure whether she should be satisfied or dissatisfied by this observation.

"Not necessary for a woman to know," she repeated, "to be sure, it is not absolutely necessary; one could live without it; yet I do not see why a woman should not know scientific expressions, as well as men."

"You are very welcome to know them, my dear," said Harry; "I do not make any objection. Am not I teaching them to you. But I hope, my dear Lucy, you will never use them."

"Never use them!" said Lucy.

"In the wrong place, I mean," added Harry.

"No danger, if once I understand them rightly," said Lucy.

"Still you do not quite understand me," said Harry. "If you knew the meaning of the words ever so well, there might be danger of your using them in the wrong place."

"Oh! Harry, how could that be?"

"Ask mamma, and she can tell you better than I can," said Harry.

"But tell me as well as you can," said Lucy.

"Then, for instance," said Harry, "if you were to talk of '*au refus de mouton*' before company, just to show that you knew the expression, or could say it. Do you understand me now?"

"Yes, but I would never do such a foolish thing," said Lucy.

"Pray do not, my dear sister," said Harry, "for it would make me feel horribly ashamed."

"I shall never make you ashamed of me, I hope, brother," said Lucy. "I will take great care. But there was another thing I was in a great hurry to say, before you went off to this. Why is a battering hammer, or a machine for driving down posts, or, what do you call them? piles, called a mouton?"

"I do not know," said Harry.

"I think I have found out the reason," said Lucy.

"Have you," said Harry, "then you are much quicker than I am, but that you always are."

"Only about words," said Lucy, "and I am not sure that I am right, but I think perhaps it is, because sheep sometimes butt this way with their heads."

"I do believe you are right," said Harry. "This must be the meaning of battering-ram. It never struck me till this minute. But I do not know what I shall do for want of nails to nail these leather hinges on my gate posts."

Lucy recollected having seen some ves-

terday, left sticking in the lid of a deal packing case, perhaps these would do. She ran to ask her mother if she might have them, and soon returned with them, and with a hammer, which had been used at the unpacking of the case, and which, though it belonged to the carriage toolbox, her father lent her, trusting to her returning it punctually.

"Not only quick in words but in deeds," said Harry, as she put the nails and hammer into his hands.

The hinges were fastened on, and Harry pronounced the lock to be finished.

"But after all," said Lucy, "here is your lock and your canal, but where is your boat to go upon it? Now you must make a boat, or a canoe, Harry. Yours indeed must be made out of a branch, not from the great trunk of a tree, to be in proportion to your canal."

"True," said Harry, "a branch as you say will do, but what size must it be? I must consider that, before I ask papa to let the woodman give it to me."

"You might do it by the rule of three," said Lucy; "as the great canal is to the great boat, so must the little canal be to the little boat."

"Well," said Harry, "do the sum for me, here is a pencil and a bit of paper."

"But stay," said Lucy, "there is something more we want: I must have the measures of the great canal and the little canal, and the size of the great boat."

Harry measured his little canal, and gave breadth and depth to Lucy, who multiplied them rightly into one another. The measures of the great canal and the great boat he did not know, but his father estimated them for him, nearly enough to answer his purpose. Lucy and he worked out the sum patiently that evening; and when he knew the size required, his father gave him an order upon the woodman for a branch, or piece of a branch, of the requisite dimensions. He also borrowed for him a mallet, a chisel, and a gouge, and even an adze, which were necessary tools for hollowing out the solid wood, and for



shaping the outside of the intended canoe. This last indeed is a dangerous tool, and should never be trusted without circumspection to young or to old hands, unless they be skilful and careful. Harry, both careful and skilful, for he had been practised in the use of this tool, under his father's eye at home, was trusted with it now; but upon special condition, that Lucy was never to touch it. A condition to which Lucy, having just fear of her shins, as well as proper habits of obedience, willingly submitted.

As the hollowing out this canoe, chip by chip, was likely to be a tedious operation, Lucy left Harry and his adze to themselves, and went to her own amusements, upon the shelly shore. As she was creeping along, searching for shells, an old woman crossed her path, carrying on her back a huge basket full of sea weed. The woman's foot hit against some shingles on the beach; she stumbled, and let fall her basket, the contents of which were overturned on the sands. Lucy went to fill it

again for her, and now seeing that she was the gate-keeper, who lived at the entrance of the wood, took hold of one of the handles of the basket, and helped her to carry it home.

Dame Peyton, for that was the old woman's name, thanked her, and accepted her offer, more, perhaps, for the pleasure of talking to the young lady on the way, than for any use in her assistance. The load, though bulky, was very light. The basket was chiefly filled with the little black bladders of a particular kind of sea weed. These, when dried and oiled, she strung, and sent by her daughter to the shops in a town hard by, where they were made into necklaces and bracelets, for whosoever, gentle or simple, might chance to have a liking for such. The dame loved talking, and she pursued her discourse. "You were a-looking for shells, miss, when I came by, I suppose; and if I may be so bold, I can show you more in an hour than you would find in a week without me; for I know where the beds of them lie, and where the sea urchins

bide, miss, if ever you heard of them urchins."

Lucy was eager to find a sea urchin, and had been searching for one in vain. As soon as they reached the cottage at the gate where she lived, Dame Peyton pointed to a shelf in her corner cupboard, on which were several shells, which had been left there by her sailor son, who had picked up some of them from the neighbouring sands, and some from foreign parts.

The shell of the sea urchin, which Lucy first examined, was about the size of an orange, the shape of a turnip, and divided into compartments like a melon; the colour was lilac, but looking as if sprinkled thickly with little, white, frosted sugar-plums in some of its quarters; and in others, perforated with a multitude of holes, nearly as small as pin holes. The shell was as light as an empty egg shell. Through each of the little holes, the urchin when alive puts out its prickles or spines, which stand in all directions, round the creature's shell, like the

prickles of a hedgehog. Lucy, who had read the description of it, knew that these serve the sea urchin for legs, with which, at the bottom of the sea, it can walk, as it is said, in any direction, sometimes with its mouth upwards, sometimes with its mouth downwards, sometimes rolling along sideways, like a wheel. There was an opening at the upper part of the shell, which served for its mouth, and another opposite to it, through which the creature can at pleasure push out, or draw in what resemble the horns of snails. These, which were formerly supposed to have been its legs, the urchin uses only to feel about with, when it walks, as a blind man uses a staff to touch and try every thing that lies in his way.


Lucy, who knew all this from her books, was eager to see the fish alive, with all its spines about it. But Dame Peyton's dinner was ready, boiling over in her pot; and though the good-natured old woman would have left it to go that instant to show Lucy the haunt of the urchins, yet Lucy would

not let her. She waited till evening, and then Harry accompanied her, though rather unwilling to lay by his adze, and leave his canoe.

As he went with Lucy towards the appointed place, he objected to her wonderful account of the urchin's mode of walking on the spines. He said, that as these creatures were in the habit of walking only at the bottom of the sea, few people, only those who had gone down in a diving bell, could have observed them walking.

"You shall see, you shall see them yourself, Harry!" said Lucy.

She recollected what she had read, that Reaumur had first seen an urchin walking at the bottom of a shallow pan, full of sea water, and, at her request, Dame Peyton had provided one of her shallow milk pans to show the experiment. They found her waiting for them when they reached *Urchinstown*. She took out one from a number of these fish, which had congregated together, and put the apparently inanimate ball into the pan full of water. Presently



it sent forth some of its hundred horns through the holes in its shell, and soon stretching its spines, it appeared with all its wiry looking prickles full upon it. Thirteen hundred horns, and two thousand spines well counted.

"It moves! it moves! Now, Harry, see it rising up. Now it is putting out its feelers from beneath. Now look at it feeling about like a blind man with his staff. And now he is really beginning to walk! Look at him walking on his spines, like a wheel on its spokes. How beautifully he goes on!"

"He is an admirable mechanic!" exclaimed Harry. "Look how he uses some of his spines as a fulcrum, against which he pushes, and draws on his shell by turns. I did not think any fish could have so much sense."


Harry's admiration increased, as well it might, the more he considered these things.

"Now, Harry, you see that even my shell hunting leads to something," said

Lucy. "You will not despise shell fish, when you know more about them and their houses."

After this day, whenever Harry wanted to rest himself from his hard labour, he used to go to Lucy to learn something more of her shells.

One day she showed him the shell of the razor fish, and told him in what an ingenious manner the fish which inhabits this shell can move itself forward, or descend into its sandy hole. It does not walk upon spines, but by means of its tongue. It has a fleshy cylindrical tongue, which it can use by turns as a shovel, a hook, a borer, and a ball. When it wants to go on, it forms its tongue into the shape of a hook, which it strikes into the sand, and by which it pulls its body after it. When it wants to descend it bores a hole in the sand with its tongue, sometimes two feet in depth; and when it wants to ascend to the surface it forms the end of its tongue into the shape of a ball, which stops the bottom of the hole, and serves as a fulcrum; and



then making an effort to extend the whole tongue, pushes the shell upwards, till, by a repetition of this operation, it gains the surface.

Of all things, Lucy most wished to see a barnacle, not for its beauty, nor for its rarity, but on account of the strange stories she had read concerning it. She had first met with some account of it in a note on the barnacle, in her Bewick's British Birds; and afterwards she had copied from some other book a whole page of its fabulous history. She searched along the shore many a time in vain, for a barnacle; but Dame Peyton gave her one, which had been found by her sailor boy at the bottom of an old plank of a ship. Lucy ran with her treasure to Harry, and showed it to him. It looked something like a transparent, white, flexible gristle, branching from one centre or body, into various arms; at the end, or summit, of each branch, there was a small shell, about the size of a bean, and of the shape of the bill of a large bird. These arms, or branches, are called



pedicles, or footstalks; by these the fish attaches itself to rocks, or to the bottoms of vessels. These footstalks are sometimes of a fine red, and the shells sometimes of a violet colour.

“But now, Harry,” said she, “you might guess for ever, what, not only foolish people, but grave-naturalists, my dear, who wrote books in former times, believed, came out of these little shells: pray guess.”

“I suppose some sort of fish,” said Harry.

“No — but a bird! a goose! a great goose,” said Lucy; “out of each of these tiny shells. This was called the tree-bearing goose. And now let me read this to you, or read for yourself, if you please, and can read my small hand writing.”

Harry read as follows: —

“‘What our eyes have seen, and hands have touched, we shall declare. There is a small island —’”

Lucy put her hand over the name of the place, and bid Harry read on without knowing where the place was.

“‘There is a small island, wherein are

found the broken pieces of old bruised ships, some whereof have been cast thither by shipwreck, and also the trunks and branches of rotten trees, whereon is found a certain spume or froth, that in time breedeth into certain shells, in shape like those of the muscle, but sharper pointed, and of a whitish colour, wherein is contained a thing, in form like a lace of silk finely woven together, one end whereof is fastened to the inside of the shell, even as the fish of oysters and muscles are; the other end is made fast unto a rude mass or lump, which in time comes into the shape and form of a bird. When it is perfectly formed, the shell gapeth open, and the first thing that appeareth is the aforesaid lace or string; next come the legs of the bird hanging out, and as it groweth greater, it openeth the shell by degrees, till at length it is all come forth, and hangeth only by the bill; in short space after, it cometh to maturity, and falleth into the sea, where it gathereth feathers, and grow-

eth to a fowl bigger than a mallard, lesser than a goose, which the people of—’”

Lucy put her finger over the place.

“‘Call by no other name than a tree goose; which place aforesaid, and all those parts adjoining, do so much abound with, that one of the best is bought for three-pence.’”

“I never heard such nonsense in my life,” said Harry.

“‘For the truth whereof, if any doubt,’” continued Lucy, reading, “‘may it please them to repair unto me, and I shall satisfy them by the testimony of good witnesses.’”

“Good witnesses, indeed!” said Harry.

He asked in what part of the world, and at what time, what age such nonsense could have been believed. He supposed that it must have been in the dark ages, and at “Novazembla, or the Lord knows where.” He was surprised, when Lucy told him, that the place reputed to be the native soil of the “tree bearing goose,” was in England, in a small island on the

coast of Lancashire; and that the time when grave naturalists wrote its history was the latter end of the days of Queen Elizabeth. "But what could have given rise to such a strange story?"

Lucy said, that there was no reason given, but that the silky looking membrane, which hung out of the shells of the fish, look something like feathers.

Their mother observed, that as the barnacle goose was a bird of passage, and appeared only for a short time in severe winters, the country people had not means of learning their history, nor could they tell how they came there; and seeing the barnacle shells also but seldom, and perhaps happening to see these also in bad weather, when cast ashore on shipwrecked vessels, they had concluded too hastily, that one thing was the cause of the other, because it appeared at the same time, or just before it."

Lucy said this was natural for ignorant peasants; "but for naturalists, mamma, and people who write great books, think of

their believing that a great goose, which weighs (I have it written down here) about five pounds, and measures more than two feet in length, and nearly four feet and a half in breadth, "came out of this little shell!"

"But Lucy," said her mother, "I do not think that is the incredible part of the story."

"No, mamma! don't you indeed?"

"I do not. Do not the common geese you see every day, come from an egg almost as much less than the full-grown bird, as the barnacle shell is less than the barnacle goose?"

"That is true to be sure," said Lucy, "great birds come from small eggs, we see. But then, mother, the wonder is that the bird should come from the shell of a fish."

"Now you have it, Lucy," cried Harry.

"And why should not that be believed?" said their mother.

"Oh, mamma! and do you really believe it?" cried Lucy.

"I do not recollect telling you that I believed it," replied her mother, smiling. "But I asked you your reason for disbelieving; unless you can give some reason for your belief or your disbelief, you are not wiser than the poor people you have been laughing at."

"That is perfectly true," said Harry; "but I did not think of it till mamma said so."

"My reason for not believing it," said Lucy, "is, that it is contrary to all we ever heard or read of the history of birds or fishes."

"That is a good reason," said her mother: "all that we know of their history is from observation, or from reading the observations of others; and all the means we have of judging whether any new fact we hear related be true or false, must be from comparing it with former established facts, and considering whether it agrees with them or not."

"Yes, mamma, I understand," said Lucy; "also by considering whether it

agrees or not with what are called the laws of nature."

"And what do you mean, my dear, by the laws of nature?" said her mother.

"The laws of nature," repeated Lucy, to gain time. "Oh, mamma! you know what I mean by the laws of nature; you only ask that to puzzle me."

"No, my dear Lucy, I ask it only that you may not puzzle yourself; that you may not use words without clearly understanding their meaning."

"Is not *the laws of nature* a good expression, mamma?" said Lucy.

"A very good expression for those who understand what they mean by it," said her mother; "but no expression can be good for those who do not. To them it expresses nothing."

Lucy thought for some time, and then said, "Harry, do you try, you can explain it better."

"You mean by the laws of nature," said Harry, "things or circumstances, which have been known regularly and constantly

to happen about animals, and vegetables, and minerals, and all things in nature. I cannot express it quite, mother. But, for instance, it is a law of nature that the earth turns round every twenty-four hours."

"Yes, that the sun rises every morning," said Lucy. "And in the same way it may be said to be a law of nature, mamma, that birds do not come of fishes' shells."

"Very well, between you, you have explained pretty nearly what is meant by the laws of nature," said their mother.

"What, from the beginning of the world, was never in any instance known to happen, we do not believe *can* happen," said Harry, "I mean in nature. And yet," continued he, "new facts are discovered, which sometimes prove, that what was thought to be quite true, and a settled law of nature, is not so."

"But," said Lucy, "to go back to the barnacle goose tree. Harry, suppose that you and I had lived in Queen Elizabeth's days, and in Lancashire, and near that



island of geese, do not you think that we should have believed in the goose-tree?"

"I hope not," said Harry, "but I am not sure."

"Suppose that a great many people had told you, that they were sure there was such a tree," said Lucy, "what would you have said then?"

"I would have asked whether they had seen it themselves, or whether they had only heard of it from others," said Harry, "I would have questioned the people separately, and have observed whether they all agreed or disagreed in their answers. And, above all, I would have gone to the place, and would have examined the barnacle shells with my own eyes. Then I think I should have perceived, that what people had mistaken for feathers of a bird, were the membranes, or, what do you call them, Lucy? *tentacula* of a fish. I would have returned at different times of the year, to watch what became of the barnacles, and then I think I should have found the truth."

‘ And I think, Harry,” said his mother, “ that if you follow such a prudent course, in judging of extraordinary assertions, you will never be the dupe of wonders or wonder-makers. Whenever either of you feel inclined to believe in a wonder, without proof, pray remember the barnacle goose and the goose-tree.”



So long as Lucy had any ingenious contrivances to show Harry in her shells, or any curious anecdotes to tell him of the modes of life of their inhabitants, he looked, and listened, and was pleased; but he ceased to be interested, and looked dull, when she told him any of their hard names. He, however, admitted, that the great classes into which shells are divided are easy to remember, and he liked their names, *univalves*, *bivalves*, and *multivalves*. Lucy placed before him a snail shell, an oyster shell, and a barnacle, as examples of each class. He examined the curious construction of the hinges of various shells,

but farther he had no curiosity; he could not, he said, understand the use of Lucy's spending so much time in settling to what order each shell belonged. Lucy had much to say in favour of the use and advantages of classification to preserve things in order in our memory, and to assist us in recollecting them more easily; but it was not a good time to enter upon the subject now, because Harry's head had gone back to his boat. He had finished it, and he wanted her to come out and look at it. She put aside her shells directly and followed him.

The boat, it must be confessed, was but a clumsy affair; the few tools that Harry had were in very imperfect order; but he forbore to complain, because he had once heard from Lucy a French proverb, "*Un mauvais ouvrier se plaint de ses outils.*" A bad workman complains of his tools. Imperfect as the boat was, Lucy viewed it with indulgence, and when harnessed to it, she towed it along respectfully and with the greatest circumspection, often looking

back to see that she did not upset or *strand* it by pulling it against the bank. Harry, however, remonstrated against her looking back, which he observed was out of character for a horse; he told her, that she should go steadily on with her head down, and that he would take care of all the rest, and guide and govern horse and boat. The boat was on the upper branch of the canal, and Harry, as *lock-man*, shut the lower gate, so that the lock might fill. But the lock did not fill! The water indeed rose a few inches, but gushed out with sad velocity between the gate posts and the sides of the lock. Harry stood calmly contemplating this disappointment, and considering how he could make good the defect, when Lucy, who observed that the water was actually subsiding instead of rising, said,

"Indeed, Harry, you need not stand there looking at your posts, for all the water that was in the lock has run out; I think it has found some other channel."

"True," replied Harry, "we must stop

up our useful dam once more, and then we shall discover the fault. No knowledge like that we gain by experience."

The dam was soon stopped ; and, when the lock was nearly dry, Harry perceived, that the pressure of the water when it had begun to rise had torn away the loose earth under the gate, and escaped almost as freely as if there had been no gate. After due deliberation on the best means of obviating this unforeseen evil, he resolved to fix a *sill* in the bottom of the lock, from post to post, so that the gate should shut tightly against it.

"Lucy," said he, "one of those old posts, which I so awkwardly spoiled, will now be of the greatest service."

Two days were occupied in this undertaking, the sill was at last securely pegged down to the ground ; and for fear of a similar misfortune with the upper gate, he laid a sill to it also. To prevent the weight of water from undermining these sills, he paved the bottom of the whole lock and a small portion of the canal with

large flat stones; and the intervals between the gate-posts and the lock sides he puddled with great care. Another happy thought occurred to him; he had felt the difficulty of opening the gates when the water was bearing against them, and he now provided means for letting it off gradually, by boring two round holes in each gate, into which he fitted plugs, in imitation of the *sluices* in the real lock.

A satisfactory trial was made of their work, and having ascertained that all was right, Harry ran home, and requested his father to come and see his boat going through the lock. His father came; and first it was to go down the stream. When it came within proper distance of the lock, the lower gate was closed, and the sluices of the upper gate were opened by Harry with due ceremony, and with proper apologies for not having double gates. The lock was now brim full to the level of the stream, through which the boat had passed. The boat entered — the gate behind it was shut — Harry opened the sluice of the

lower gate, and by happy degrees the boat sank as the water flowed out, till it came down to the level of the lower branch of the canal. Then the lower lock-gate was opened, and out was drawn the boat safely and happily.

"Just as well," said Lucy, "as it was managed in the real lock on the real canal."

"Say on the great lock on the great canal," said Harry, "for this is a *real* lock, is it not, father? though it is small."

To reward him for his perseverance, his father promised Harry to provide him with the tools necessary for the better finishing his boat. He showed him the principal faults in its shape, and explained to him, that the middle part of a boat or ship is made broad, or *full*, in proportion to the kind of cargo it is intended to carry; that the foremost end, or *bow*, is rounded off to a sharp edge called the *stem*, or *cutwater*, in order to lessen the resistance in moving; and that the *stern* is made very narrow

under water, to allow the full impulse of the water to strike the rudder.

Soon afterwards his father took Harry with him, to see a boat, which was building at some miles distance from Rupert Cottage. There he learned how the ribs of a boat are put together, and fastened to the keel, so as to make them as strong and as light as possible. Harry told Lucy, when he returned, that the frame-work of a boat, before the boards are put in, looked like the skeleton of the dead horse, which they had often seen in a grove near their father's house. He told her, that he had heard the boat-maker and his father talking about ship building; and of some great improvements that had been lately made. Harry could not understand much of what they said, because he had never seen the inside of a ship; besides, the boat-builder talked in workman's language, using a number of terms that were familiar to shipwrights, but not to him; and taking it for granted that every body must know what he was talking of.



“ I picked out, however, some things that interested me,” said Harry ; “ particularly some that concern the steam-vessels. These improvements in ship-building have been of great use to them. People have learned how to put the timbers together, in such a manner as to make vessels much stronger than they were formerly ; so that now they can bear the *straining* and *working* of the steam-engine. I heard the man say, that unless they had been so strengthened, engines of such great power could not have been used : in short, they could not have made the steam-vessels carry so much, or go so fast or so safely as they do now.”

“ That is good for the steam vessels,” said Lucy, “ and for all who go in them ; and some time or other, perhaps, I shall go in one myself. But, Harry, you said there were other things you heard, which interested you ; what were they ? ”

“ Oh, I heard of one very ingenious and useful invention,” cried Harry, “ for taking down easily and quickly the upper

masts—top-masts, as they call them, of ships.”

“Upper masts! top-masts!” repeated Lucy; “I do not understand what you mean. I thought the mast of a ship was all in one; a great thick, straight, upright pole, like the stem of a tree.”

“But it is not all in one piece,” said Harry. “There is a piece put on at the upper part of the lowest mast, to which sails are hung, which are called top-sails; and that piece is called the top-mast. It is often of great consequence for sailors to be able to take down and put up the top-masts quickly, as my father explained to me. Sometimes a top-mast is broken by a high wind, or a sudden squall, and till they can replace the broken mast, you know, they cannot make use of the sail that belongs to it. Perhaps at that moment the ship may be running away from an enemy, or perhaps trying to escape from some rocky shore on which they are afraid of being wrecked.

“Then to be sure the sailors must be in

a great hurry," said Lucy, "to get down the broken mast directly."

"But they could not do it directly in the old way," said Harry; "it required a great many men pulling and hauling, and a great deal of time, an hour at least, even if there were plenty of men; and sometimes there are few men, and then it takes a longer time; two hours very likely: now, by this new invention, they say it can be done by one man, or two men at the most, and in five minutes, or less."

"And how is this done?" said Lucy. "Will you tell me the old way first, and then the new way, if you can make me understand them?"

"I do not understand them myself yet," said Harry; "but I shall soon know more about the matter, I hope. My father is to go next week to see a friend of his, who lives near Plymouth; and there is a great dock-yard at Plymouth, and a number of ships there; and amongst them there is one that has this new invention."

"But are you to see it, my dear Harry?" said Lucy.

"Yes, my father says he will take me with him," said Harry; "is not that good?"

"Very good; and next week too! and you will tell me all about it, Harry, when you come back; and I hope you will see a man of war, and that you will describe that to me too," said Lucy.

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Next week arrived, and Harry's father took him to Plymouth, and to the dockyard. On his return he told Lucy, that he had seen and heard so much, that he did not know where to begin his description, or what to tell her first.

"First tell me about the man of war," said Lucy, "if you saw one."

"I saw many," said Harry, "and I went on board one, and all over it; but it is impossible to give you any idea of it."

Harry, however, attempted to give her an idea of its magnificent size, the height

of the masts, the spread of the sails, the intricate rigging, the coils of ropes on the deck, and the vast thickness of the cables, which were to draw up the huge, ponderous anchor. Then he described the accommodations, and all the conveniences for living in this floating wooden town. It was more like a town than a house, he said; as it was of such an extent, and contained so many inhabitants; several hundred men, and all their provisions, and all they must want for living months, perhaps years, at sea. He described how the sailors' hammocks were slung, and how they were aired every day on the deck. Then he described the captain's cabin, a large handsome room, with a sofa and writing table, and a book-case, and all the comforts and luxuries of life. But principally Harry expatiated on the manner in which the arms were arranged in the gun-room, in star shapes and curious forms, which at first he thought was merely for ornament; but he learned that they were all so placed, in order that they might take

up the least possible room, and that they might be found easily in time of need. And in the store-rooms he observed, that every thing great and small, down to the least bolt, screw, or nail, had its own place. The use of order was seen there to the greatest perfection.

“ In *time of action*, as they call it,” said Harry, “ meaning in time of battle, and in a storm, when the safety of the vessel and the lives of the men all depend on their being able to find what they want in a moment, consider, my dear Lucy, what advantage it must be to have them all in order ! But I cannot give you a right idea of it. You must see it, Lucy ; and I hope you will some time.”

“ And I hope then you will be with me,” said Lucy.

“ I hope so,” said Harry ; “ so now I will tell you about the *fid*.”

“ What is a *fid* ?” said Lucy.

“ A thick iron bolt,” said Harry, “ which is run through a hole in the *heel*, or lower end of the top-mast, when the top-mast is

up in its place. The ends of the fid rest upon two strong bars of wood, which are fixed to the *head*, or upper end of the great lower mast. The top-mast stands up between these bars, and the fid, you perceive, Lucy, supports its whole weight, as well as that of all the sails and yards which are hung on it. And besides all this weight, there are several thick ropes from the head of the top-mast, which are called *shrouds*, and which are fastened down very tight, in order to steady it. Now you must understand next," continued Harry, "that when the top-mast is up, it cannot be taken down without first taking out this fid."

"But what a very odd name *fid* is," said Lucy.

"Fiddle-faddle," said Harry; "never mind that; one name is as good as another, when you are used to it. Now let me explain the thing itself. Before the fid can be pulled out, the whole weight of the top-mast must be lifted up off it; and before this can be done, all the ropes

which steady it on each side must be loosened. To lift this great weight there must be great pulling and hauling; and altogether it is a long difficult job, and many men must work hard at it, and for a long time. But now, without loosening a rope, and with only one or two men, they get out the new *lever fid* in a few minutes."

"How very nice!" cried Lucy.

"Nice!" repeated Harry, "what a word, when talking of the masts of a great ship!"

"One word is as good as another, when you are used to it, as you said about *fid*," replied Lucy, laughing. "But what is the contrivance, you have not told me that? Can I understand it?"

"Yes, if you understand the general principle of the use of the lever. Are you clear of that?"

"I believe I am," said Lucy; "I know what you have told me, and shown me, that the greater the space your hand passes through in moving the long end of a lever,



the more weight you can move at the short end of it."

"Very well; you might have put it in other words—but I believe you understand something about it," said Harry. "Now for the *new lever fids*. Instead of one great bolt run through the mast, there are two strong levers, one at each side of it; and they are fixed on the same bars which supported the ends of the common old fid. When the top-mast is up in its place, the short arm of each lever goes a little way into the hole in its heel, and the long arm is securely fastened by a small pin to a frame of wood. When it is to be lowered, the little fastening pins are taken out; the levers immediately tilt up, and down comes the top-mast; but not with the sudden and dangerous jerk you might suppose, because there are ropes from the long arms of the levers, by which the sailors manage the affair as gently as they like."

"So then," said Lucy, "you mean that these two little pins, from being applied

at the ends of the long arms of the levers, have power to *balance* the whole weight of the great top-mast, and all its ropes and sails, and other things, that are supported on the short arms: how wonderful!"

"There is the wonderful power of the lever, Lucy," said Harry.

"Then you could lift any weight in the world with a lever, if you had but one long enough and strong enough," said Lucy.

"If I had space and time enough, and something to stand upon," said Harry. "I am glad, Lucy, you are so much struck by the use of this wonderful power; for, as my father said to me, when we were talking about the fid, on our return home, it does not much signify whether we know the best way of lowering the top-mast of a ship; but the principle of the lever, it is of great consequence that we should understand; because in some way or other, little or great, we have to use it every day, in the most common things."

"Yes," said Lucy; "for instance, at this moment, when I am going to stir the fire,

"I suppose studying the law," said Lucy, and, as they say, being *called to the bar*."

"But," said Harry, "I meant to ask, what do you think first turned his mind to the law, or determined him to become a lawyer? My dear, it is a foolish question of mine, because you cannot guess; so I will tell you: it was his love of mechanics."

"How could that be?" said Lucy.

"I will tell you," said Harry; "I heard the whole story; for a gentleman, a friend of his, who had known him from a boy, and as well as he knows himself, was telling it on shipboard to my father. This is what I wanted to come to all the time I was telling you about the *fid*. The inventor, who has made such a useful invention, which will probably save many ships, and the lives of all that are in them, has often said to his friends, that he owes all his success in life to his early love of mechanics. When he came home from school, he used to employ himself in doing all the little mechanical jobs that were

wanting about the house ; he used to mend the locks, for instance : then, in taking a lock to pieces, he saw how it was made, and by degrees learning the use of tools ; he made many things, which he could not afford to buy when he was a boy."

" What sorts of things did he make ?" said Lucy.

" I do not know *all* ; I only heard of a desk and a little cabinet, I think. Then he took to pieces an old watch of his father's, and learned how to put it together again. When he left school, he lived two years at home with his father, and sometimes he employed himself in drawing maps. In attempting to draw portions of very large circles on his maps, he found great difficulty for want of right instruments ; and he invented and made for himself an instrument, by the help of which he could, as his friend described it to my father, draw these small portions of circles without the necessity of using compasses, or finding a centre."

"I wish you had invented that, Harry," said Lucy.

"I!" exclaimed Harry: "but do you know he was only eighteen at that time? Well, he was one day using his instrument, and not at all aware that it was any thing but a help to himself, when a gentleman came into his father's study, where he was drawing; this gentleman was charmed with the invention, and advised him to offer it for sale to some optician, or some maker of mathematical instruments. He determined to follow this advice, and set about directly and made one neatly in brass, and carried it to London to an optician, who approved of it, and gave him for it an air pump, and an electrical apparatus, and some other instruments!"

"Delightful!" cried Lucy. "And what did he do next?"

"He improved his own little instrument by adding a scale to it; then other people used it and found it answered, and at last, what do you think? he had a silver medal

voted and presented to him by the Society of Arts, when he was yet a boy, as his friend said, not out of his *teens*."

"A silver medal from the Society of Arts! I know the look of it," said Lucy. "I saw one that was given to a friend of papa's: I remember seeing it in its little crimson case, lined with satin. But what an honour for a boy!"

"He did not stop there," said Harry, "he went on—"

"I know; to the fid," cried Lucy.

"Stay a bit," said Harry; "we are not come to the fid yet. During those two years he lived in a lonely place in South Wales, and his attention happened to be turned to the shoeing of horses. Some horse of his father's was ill shod, I suppose, and he considered how to prevent horses' feet from being cramped and hurt by their shoes. He invented an elastic horse shoe."

"Better and better!" said Lucy.

"Stay a bit," said Harry; "it was

tried upon the horses of some regiment of horse guards, and it did not do."

"What a pity! that must have vexed him very much," said Lucy.

"Not at all," said Harry; "I should think not. A man cannot expect always to succeed in every thing, much less a boy. But though the horse-shoe did not succeed, yet it led to the most important event of his life."

"How? tell me that," said Lucy; "I am always glad in lives when we come to those words."

"Tell me first," said Harry, "do you know what is meant by taking out a patent?"

"Not very well," said Lucy.

"Not very well! But do you know at all? Do you know what a patent is?"

"Not exactly," said Lucy; "but I have read about patents and monopolies in the English history long ago to mamma, in the reign of King James, or King —"

"Never mind about the kings or their

reigns," said Harry. "Go on to the thing, if you know it."

"I know that the kings of England were blamed," said Lucy, "for granting these monopolies and patents."

"But what were they?" said Harry.

"I believe they were permissions granted to particular people to sell particular things, and orders that none should sell those things but themselves," said Lucy.

"I did not think you knew so much about it," said Harry. "How came you to know that?"

"The way I know most things that I do know," said Lucy. "Mamma explained it to me, when I was reading to her."

"But those were some of them unjust patents; and mamma explained how and why, I dare say," said Harry, "as my father did to me yesterday. But there are patents in these days, which I think are very just: laws, which, by granting some writing called a patent, secures to whoever makes any new useful invention, the right to sell



it to others, and to have all the credit and profit of it for a certain number of years, as a reward for their ingenuity."

"Very fair," said Lucy.

"This gentleman wanted to have a patent for his horse-shoe," continued Harry, "and before he could obtain it, it is necessary, they say, to make out, in a sort of law paper, a description of the invention in lawyer's words. He went to a great lawyer to do this for him; but the great lawyer was no mechanic, and he did not understand and could not describe the thing at all. He did the law words rightly, but the mechanic himself was obliged to write the description; so, borrowing the law terms from his lawyer, he put the description in himself, and he did it well, and it was thought by others to be well done. Now he found that some lawyers are paid a great deal of money for drawing out these *patent descriptions*\*,

\* *Specifications* is the word which Harry did not know.

or whatever they call them. This first put it into his head, that if he knew as much of law as was necessary for this, he could do the whole himself, and earn his bread by doing it for other people. This determined him to learn law, and he did: so you see, as I told you, his love of mechanics first made a lawyer of him. He acquired all the knowledge requisite; and now, as his friend said, he is unrivalled in England, in that particular employment. But now I must tell you another curious circumstance," continued Harry, "to show you how, after he was a lawyer, he was brought back to mechanics again. It happened that he was employed as an advocate, in some cause where there was a dispute about the loss of a cargo, or the goods on board a merchant ship which had been wrecked. He was to examine the captain of the ship, in the court of justice, to find out whether he had or had not done all that was possible to save the ship and the cargo. In this examination, he asked the

captain some question about the lowering the top-masts. The captain laughed at him for his question, whatever it was, because it showed that he did not understand rightly how the top-masts were to be got down. The captain explained this to him, and showed him the difficulties, and I suppose told him all about the fid—the common old fid, I mean. He perceived what an inconvenient contrivance it was; and that very evening, after the trial, by considering how a fid could be better managed, he invented the lever-fid. His friend said, that when he went to his supper, he cut out the shape of his lever-fid in a bit of cheese, and thinking that it would answer its purpose, he could not go to rest till he had made a nice little model in box wood. He made model after model till he was satisfied. Then how to get it into use was the next difficulty. The gentleman said a great deal about the *Lords of the Admiralty*, that I did not understand: but, in short, his contrivance was approved by them, and they

ordered that all the assistance he wanted should be given to him, for trying it in some one ship. The Maidstone frigate, I remember, that was the name of the ship in which it was tried, and it succeeded perfectly. The first time the ship went out to sea with it, the top-mast was to be taken down; and this was done so easily and quickly, that all felt the use and excellence of the invention; and the officers of the navy have given it their decided approbation, and it has been brought into use in a great many ships."

"How happy the man who made this invention must be!" added Harry.

"And his sisters, and his father and mother," said Lucy; how glad they must be to see it succeed so well, and to know how useful it is."

"An invention useful to all the British navy. What a grand thing!" said Harry.

After pausing, and considering for some time, Harry added,

"Yet he was once a boy like me, and trying little mechanical experiments. My

dear Lucy, I heard his friend telling my father something, which made a great impression upon me; the more so, because he was not thinking of me, or that it could do me any good to hear it when he said it."

"What did he say?" asked Lucy eagerly.

"That this gentleman attributes all his success in life to his having early acquired a taste for mechanics, and to the habit of trying to invent and to improve his early inventions, in those two years, which he employed so well at home, when he came from school, and before he was fit for any profession; a time which they say many boys waste in idleness."

"I am sure you never will, Harry," said Lucy.

"No, after hearing this I think it would be impossible I should," said Harry. "This has raised my ambition, I assure you. But I must go on as he did, learning by degrees, and be content with doing little things first."

“What will you do next,” said Lucy, “now you have finished your boat and your lock?”

“I have a plan,” said Harry. “You shall know it to-morrow.”

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HARRY's new project was to build a bridge over a little mountain stream, which had often stopped his mother in her walks. He had already laid a board across, from bank to bank, and had fixed it steadily; but upon this two people could not walk abreast, nor could the ass cart pass this way, it was necessary to take it by another road, a quarter of a mile round. That a bridge at this place would be a *public* and private benefit seemed evident, and Harry was ambitious of building a real, substantial arched bridge, which should last, he would not say for ever, but as long as man could reasonably expect a bridge to last. This project was heartily approved by his prime counsellor, Lucy, before whose quick

anticipating eyes the arch instantly rose complete.

"And when it is built," cried she, "it shall be called *Harry's bridge!* or *My mother's bridge!* which shall we call it, Harry?"

"Let us build it first," said Harry, "and we may easily find a name for it afterwards. Come with me to the place, Lucy."

When they reached the spot, Harry bid her guess what the distance was from bank to bank. She guessed about a yard and a half.

"A yard and a half! such a woman's measure. That is, four feet six," said Harry.

Such a man's measure! six what? Lucy might have said, had she been disposed to retort criticism, but that was far, far from her disposition. She knew what he meant, and that was all she thought of.

"Four feet six inches," said she. "Is it more or less?"

"You are within half a foot of it, my

dear," said Harry. "My arch must be a five feet *span*. I mean that the width across from buttment to buttment, from foundation stone to foundation stone on the opposite sides, must be five feet. But there is my father," cried Harry, "on the sands below, at the very place where I want him to be. I will show him my plan directly."

Down the hill ran he to the sea shore, and down ran Lucy after him with equal speed. Their father was stopped short, and the bridge project started, and his consent, assistance, and advice anxiously requested. Lucy thought his first look was not favourable. He shook his head, and answered, that he feared Harry would find it beyond his skill or present knowledge to construct an arch.

Harry stood quite still and silent for a minute or two; then collecting himself, he deliberately answered,

"I remember, father, your showing me long ago an arch, which you made for me of a thin lath between heavy weights,



half hundred weights from the great scales, which were placed at each end for buttments. Then I pressed on the top of the arch, and felt how strong it was; it bore all my weight I recollect. This, I think," continued he, in a very modest but firm tone, "made me understand the great principle of the arch, which, as you told me at the time, depends on the buttments being secure. And I will take care and make the buttments of my bridge strong enough."

"You will do well, Harry; and you remember well and understand one great principle on which the security of an arch depends, but there is much more to be known and considered. However, my dear boy, try and build your bridge; you will learn best from your own experience; you may amuse and instruct yourself at the same time. Tell me what assistance you want, and I will tell you whether I can give it to you."

"Thank you, father. Then, in the first place, will you come on a few steps, that I

may show you my arch, which I have drawn on the sand, and will you give me your opinion of it?"

Lucy ran on before to see it first, and then waited anxiously to hear her father's opinion. She saw surprise in his countenance the moment he looked at the arch described on the sand.

"This is well done, Harry. This will do," said he. "Who showed you how to describe this arch, or how happened it that you chose this shape more than any other?"

"Nobody showed me how," said Harry, "but I took it from the little bridge which I saw the mason building in that lane, where we went to look at the road mending. I measured the centering as it lay on the ground when they had done with it, and I drew my arch exactly by that centering."

"What is the *centering*, Harry?" whispered Lucy.

"A sort of wooden frame, on which the stones of the arch are supported, while it

is building," said Harry, "for you know they could not hang in the air."

His father told Harry he thought he had done wisely to take advantage of the experience of a mason, who was used to build bridges, instead of going to work rashly, without knowing what he was about.

"But, father," said Harry, colouring, "I do not think I deserve to be praised for prudence; I was not prudent at all, at least not in the way you think. I would much rather have done it all myself, and drawn my arch my own way, and different from this; but I took this curve because the masons centering will fit it, and I thought you could borrow it for me; and that, though you might perhaps allow me to build the bridge, you would not like the trouble or expense of getting boards for me to make a centering for myself; besides, I was not sure that I could make it all myself."

"Well, Harry, since I cannot admire your prudence, I am the more satisfied

with your honesty. Now what assistance do you want for your bridge: consider, and let me know to-morrow."

"I have considered already, father," cried Harry, "and if you please I can tell you all to-day, and this minute. Stones in the first place, and I know where they can be had, and where they are of no use; in the ruins of the old garden-wall, which is now rebuilding of brick."

"Granted, as many of them as you want and can carry," said his father.

"But there are some too heavy for me," said Harry. Will you order the boy and the ass cart to bring them?"

His father assented.

"And will you order for me lime and sand enough for mortar?"

"If you can tell me how much of each you want, Harry."

He could, for he had inquired from the mason how much had been used in building the bridge of the same size, and he named the quantities. Then he had farther to ask for a bucket, a hod, a trowel,

and a plumb-line, and the mason's centering, and the mason or the mason's man, if he could be had, for three days, to assist him in lifting and placing the heavy stones.

Lucy held her breath with anxiety, while Harry uttered all these requests, fearful that so many at once could not be granted ; but her father was pleased by Harry's making them all at once, and by his having so well considered what was necessary for his undertaking. Bucket, hod, trowel, plumb-line, and centering, all were granted ; but there was a doubt with respect to the mason, or the mason's man.

"I am willing to give you all necessary assistance of hands, but not of head, Harry. I cannot let you have the mason, but I will lend you for three days the mason's man, who, if I mistake not, has hands but no head."

"I am glad of it, father," cried Harry ; "I mean so much the better for me, because, if he had ever so good a head it would be in my way ; it would hinder me

from using my own. Then I should not learn, as you said, from my own experience. I would rather do all that I possibly can of my bridge for myself. I am sorry the arch is not my own, but that could not be helped, you know, father, on account of the centering."

"However, just the curve of the arch does not much signify, I suppose," said Lucy. "One shape, one curve of an arch is much the same or as good as another, though not so pretty, perhaps."

"There you are quite mistaken, Lucy," said her father. "One curve, on the contrary, may be as pretty but not as good as another, not as capable of sustaining weight, not as durable. There is a great deal of difference between one curve and another for a bridge, as Harry, when he has more knowledge of science, will be able to explain to you."

Harry again expressed his regret that he had this arch laid out ready to his hand.

"In short," said he, "now the most difficult, the most scientific part is done,

and I have only to do the easy mason-work part, which any body can do without making any mistakes, or requiring any ingenuity."

"There is no danger, Harry, of your not finding sufficient difficulty before you have done. There is room enough left, I promise you, to make mistakes, and to exercise as much ingenuity as you possess."

Harry brightened up again on hearing this, and so did Lucy.

"The more difficulty, the more glory," said she.

As soon as all was provided, which was not quite so speedily as Lucy wished, Harry set to work; first he cleared and levelled a place on the bank on each side for his foundations. Then while the heavy stones were drawing up by the ass, he was busy, very busy, making mortar, with the assistance of the man *without a head*. The great foundation stones were then placed, Harry taking particular care to choose the most solid, weighty stones, and to have them laid level and firm.

Then came the wooden frame work, that was to support the mason work while they were building the arch — the centering, as Lucy knew that it was called, and she would have liked to have examined it, but she would not interrupt Harry at this moment, for he was eager to have it put up, and to get on with the work. Therefore she stood by without interrupting the operations by question or remark. The centering was hoisted up and fixed by Harry and the headless man, whose hands and length of arms were, it must be acknowledged, of manifest use upon this occasion. The wooden arch was raised to the height at which the stone arch was to be built upon it; and it was supported at each side by upright props. Between these and the wooden frame, wedges were put in; and Harry, busy as he was, stopped to explain to Lucy, that these wedges were to be knocked out when the bridge was completed, and that the wooden arch being removed, would, as it was to be hoped, leave the stone one standing firm.



Then the building of the arch began. We cannot follow the work, stone by stone, as Lucy did, with untired sisterly sympathy, not only stone by stone as each was placed, but as they were many a time displaced, and tried over and over again before they fitted. To Lucy's surprise and mortification, she observed, that even the stupid mason's man, by long practice, could judge better which stones would best fit, and how they would best go into certain places, than Harry could with all his quickness of eye and sense. This was most apparent the first and second days; on the third, after even this little practice, Harry found his eye and hand improving, and his sense began to get the better of his awkwardness at his new trade. After this third day's long and hard and hot labour, the arch rose from each side till it nearly met at top, and wanted only the putting in of the last stone, the key stone, to complete the work. Harry showed Lucy, that when this was put in, all the parts of the arch were pressed together,

and that none could give way without displacing the others; each part tended to support each, and to hinder any stone from being pressed upwards or downwards more than another.

"So it is impossible it should come down as long as it is an arch," said Lucy.

"As long as it is an arch impossible," said Harry. "All we have to desire is, that it should never alter from this shape; and I do not see how it can," continued he, looking at it, "my buttments are so secure, there is no danger of their giving way or being thrust out by any weight that will go over the bridge."

"Now then," said Lucy, "you will take away all this wooden under-bridge, and these props, and you are to knock out the wedges, that you may take down the centering, now the bridge is finished."

"Not yet," said Harry, "we must leave it some time for the stones to settle, and the mortar to dry a little."

Lucy's impatience yielded to her brother's prudence, but he was very eager

himself for the taking down of the centering. That trying time at length arrived, an anxious moment even to old experienced architects, veteran bridge builders. The wedges were knocked away — the props fell — the centering was lowered and withdrawn from under the arch — and it stood! Harry took breath, and pushed back his hat off his hot forehead. Lucy clapped her hands, exclaiming,

“It stands! Harry’s bridge stands. It shall be called Harry’s bridge!”

“No, My mother’s bridge,” said Harry, “if you please. It was for her I built it.”

“And I will run and call her to see it,” cried Lucy.

“And I will go for my father,” said Harry. “I hope he is not busy.”

Neither father nor mother were to be found in the house. They were out riding, and they staid out till it was so late, that Harry and Lucy thought it was better not to ask them to look at the bridge till the next day. Their mother had never yet seen even the plan, she was not in the

secret. They hoped that she would be delightfully surprised. It was settled that she should be invited out to look at it early the next day. She was, as they arranged it, to be handed over the bridge by Harry, to a seat which Lucy had prepared in a recess in the rocks, on the opposite side, where she might sit and read happily.

Alas ! who can answer for to-morrow. The next day it rained, and the next, and the next poured torrents. The rain lasted without intermission a week, a long melancholy week ! — for in Rupert's Cottage they had not the same means of amusing and employing themselves, which they possessed at home; they had but few books, and those few belonged chiefly to their Latin or English lessons. Their father and mother had been promised the use of the library of a friend, who lived in the neighbourhood, and, upon the faith of this promise, they had brought scarcely any books with them. But their friend,

unexpectedly called to town upon business, was unfortunately for them absent; there was no circulating library, no book society, in this part of the country.

There was one advantage, to be sure, in possessing but few books, these were well read, and many things found in them, which had escaped attention when in the midst of greater variety. At last, they were reduced to Johnson's Dictionary; not the delightful quarto, in which there are quotations from all the best authors in our language, exemplifying the various uses of each word: with the *great* Johnson they might have happily amused themselves at night, reading those quotations, and puzzling their father and mother, by making them guess the authors. This had often been a favourite resource at home. But now they had the little octavo Johnson, in which there are only the meanings and the derivations of the words. Of this, however, they made what profit and diversion they could. They picked out

words for each other to explain, and compared their own explanation with definitions in the dictionary.

"Now, Lucy, I will give you a woman's word, *to darn*," cried Harry. "Let us see whether you can explain the meaning as well as it is explained here by a man."

Lucy made many attempts, her colour rising at each ineffectual trial, and at last she could not equal *the man's* definition of to darn,

"To mend holes by imitating the texture of the stuff."

Lucy had her revenge, when they came to network, which is thus described by the learned Doctor: —

"Any thing reticulated or decussated at equal distances with interstices between the intersections."

"Look for *decussate*," said Harry.

Lucy turned over the leaves and read, "Decussate, to intersect at acute angles."

"Well, that is something like netting," said Harry.

"Is it? how?" said Lucy.

"Why, you know," said Harry, "in a net, each mesh or stitch is intersected, is it not? at acute angles."

"But it is not intersected," said Lucy; "for to intersect, means to cut in two, does not it? and the mesh of the net, instead of being cut in two, is joined at the corners. Is it not very extraordinary, that the man should say the very contrary to what he means, and to the sense of the thing?"

"It would be very extraordinary if it were so," said cautious Harry; "but I think to *intersect* does not always mean to cut in two. I know in Euclid, lines are said to be intersected, when they are only crossed."

On turning to the dictionary, Harry found himself supported in his assertion, for there are two verbs *to intersect*. One is a verb active, meaning "to cut, to divide each other." The second is a verb neuter, and means what I told you," said

Harry; "to meet and cross each other; as in your net the threads do meet and cross at the angles."

"Yes," said Lucy, "but they must do more, not only cross, but be tied and knotted. I wish," continued she, "that dictionary makers would use easy words, instead of words more difficult than those they are explaining, at least when I am as sleepy as I am now. I can look for no more words; so good night, Dr. Johnson, I am going to bed."

"Let me put him away for you," said Harry, "poor creature, you are fast asleep."

As he went to put Johnson in his place, he saw another dictionary, by Dr. Ash, on the same shelf, and, taking it down, said he had a mind, before he gave up the search, just to look in this for network.

"It will do you no good," said Lucy; "all the dictionary people since Johnson's time have copied from him, mamma told me so; and she told me a droll story, which proves what bungling copies they



sometimes make. But I am too sleepy to recollect it rightly. Mamma, would you be so good as to tell him about curmudgeon?"

His mother asked him if he knew what is meant by a curmudgeon.

"Yes, a cross, selfish, miserly person, is not it?"

"And can you guess from what the word is derived, Harry? It is but fair to tell you, that it is a corruption of two French words, ill pronounced."

"French words!" said Harry, "then I have no chance. If you had said English words, I might have said two that just came into my head."

"Oh! say them, for I am sure they are odd by your look," said Lucy, wakening with the hope of diversion.

"*Cur munching*," said Harry; "say it quickly, and it will make curmudgeon. And a cur munching is cross and miserly, if you attempt to take his bone from him."

Lucy laughed, and tried to repeat cur munching as often and as quickly as

she could, to turn it into curmudgeon for Harry; and his mother wrote down for him the derivation, as it is given in the quarto edition of Johnson's Dictionary.

"Curmudgeon, n. s. [It is a vitious manner of pronouncing *cœur mechant*, Fr. An unknown correspondent.]"

"Now here is Ash's Dictionary," cried Lucy; "I will look for it, I am quite awake now, mamma. But stay; first, Harry, tell us what you think is meant by 'Fr. An unknown correspondent.'"

"Fr. means French, to be sure," said Harry; "and an unknown correspondent sent Johnson this derivation, I suppose."

"You suppose perfectly rightly," said Lucy; "but now look how Dr. Ash understood, or misunderstood it, for want of knowing the meaning of the two French words. Here it is.

"Curmudgeon, noun sub. from the French, *cœur*, unknown; *mechant*, correspondent."

"Excellent!" cried Harry, laughing; "let me see it."

"Oh, mamma, can you tell us any more

of such droll mistakes," said Lucy; "I dare say there are a great many more, if one could but find them; and I should like to make a list of them all."

"To shame the poor dictionary-makers," said Harry. "But that would be very ungrateful of you, after all, Lucy; for consider how often dictionaries have helped us when we were in difficulties; and how much amusement we have had from Johnson's quotations."

"In the *great* Johnson; Oh! I acknowledged that at first," said Lucy; "and you forget this curmudgeon mistake was not your dear great or little Johnson's, so I am not ungrateful."

"But you know you triumphed over him, when you had him caught in your net-work," said Harry.

"Because of his hard words," said Lucy.

"Lucy," said her father, "did you ever hear the fable of Apollo and the Critic?"

"No, papa; pray tell it to me," said Lucy; "I love fables."

"Are you awake enough to hear and understand it?" said her father.

"Yes, papa, perfectly; wide awake: curmudgeon and the munching cur have wakened me completely."

"There was a famous critic, who read a famous poem for the express purpose of finding out all its faults; and when he had found them, and made a list of them, he carried his list and his notes to Apollo. Apollo ordered, that a bushel of the finest wheat that had ever grown on Mount Parnassus should be brought; and he ordered that it should be winnowed with the utmost care; and when all the corn was separated from the chaff, Apollo presented the chaff to the critic for his reward, and banished him for ever from Parnassus."

"Thank you, papa," said Lucy; "I understand the moral of that fable very well; and I think I had better banish myself to bed now. Good night, Harry; I hope it will be a fine day to-morrow."

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It was a fine day; all the dark clouds

had disappeared, and left the sky clear blue. The sandy soil had dried so quickly, that Harry and Lucy flattered themselves that their mother would walk out this morning, and they ran to prepare her seat beyond the bridge.

But, oh! disappointment extreme! oh! melancholy sight! The bridge was no more: nothing remained of the arch but some fragments, over which the waters were rushing. The mountain stream, which had been swelled by the rains to a torrent, had not yet sunk to its natural quiet state; but was dashing down the rock with deafening noise.

Harry stood motionless, looking at it.

"I do not hear you, my dear," said he, as Lucy twitched his arm to obtain an answer: "What do you say?"

"Come a little further away from this noise," said Lucy. "I say that I am exceedingly sorry for you, Harry."

"Thank you," said Harry; "so am I sorry for myself, but sorrow will do no good."

"How could it happen, when you took

such care about the buttments?" asked Lucy.

"I did not take care enough," said Harry, "that much is clear; but it is not clear to me how it all happened, or why? The water covers every thing now; it runs, you see, over the banks beyond my foundations. We must have patience."

"Oh, how hard it is to have patience sometimes," said Lucy, with a deep sigh.

Harry could not forbear echoing her sigh, though he passed it off with a *hem* immediately, thinking it was not manly. He was determined to bear his disappointment like a man, but he could not help feeling it.

In the evening, when the waters had subsided, they revisited the place of their misfortune. While Harry surveyed the ruins below, and examined into the cause of the disaster, Lucy stood on the bank, looking alternately at his countenance and at the fragments of the fallen bridge, in all the respectful silence of sympathy.

"I see now how it happened," said

Harry. "Though I made my buttments strong enough, I did not go down to the solid rock for my foundations. I built them on the bank, which I thought at the time was firm enough."

"So did I, I am sure," said Lucy; "it was as firm and hard as the ground I am now standing upon."

"But it was all sandy soil, as you can see here, where it has been broken away," said Harry; "and I perceive exactly how it happened. When the rain swelled that mountain torrent, the water came higher under my arch than I ever expected."

"Who could have expected it?" said Lucy.

"There was not room for it to pass underneath," continued Harry; "and therefore it pressed against the sides of the arch, and rose up over the banks. Then the earth and sand were loosened, the foundations were undermined, the stones were swept away, and then down fell our arch."

"Poor arch! poor Harry!" said Lucy.  
"That horrible mountain torrent! how

violent it was. Who could have thought it, who had only seen it running gently in its peaceable way? But it is all over; we can never have a bridge here; we must give it up."

"Give it up, because I have made one mistake!" said Harry, "and when I see the cause of it! Oh, no; if my father will but let me try again—and here he is, and I will ask him," cried Harry.

His father, who had heard of his misfortune, was coming to condole with him, and to inquire how it had happened. Harry showed him. "You were quite right, father," said he, "in foreseeing that I should find room enough to make mistakes; and so I have, you see. But this was my first attempt, and now I have learnt something by experience; will you be so kind as to let me try again, and let me have the assistance of the mason's man for three days more?"

Three days more of a labourer's work, at two shillings a day! Some people would consider this a great deal too much to give



to the *mother's bridge*, or rather to the *son's bridge*; but Harry's kind father did not think so. He was pleased to find that his son was not discouraged by disappointment, and that he had immediately set about to discover the cause of his failure; and he told Harry, that he should have the mason's man for three days, to make a second trial, upon the same conditions as before.

"And will you help me, father, to find a better place for my foundations? Will you, father?"

"No, Harry; do it all yourself."

He would give no opinion or advice: he pursued his walk to the wood, and Harry was left to determine his plans. After much careful deliberation, he decided on a place a little higher up the stream, where the foundations of his buttments would stand upon the solid rock, so that no treacherous sand or loose earth should be washed away by the torrent, and again expose them to be undermined.

After settling this point, and measuring

the span and other dimensions, he repaired to the sea-shore, to draw the plan and elevation of his second bridge. The stream being rather wider, and the banks much higher in the new situation that he had chosen, it was clear that the arch could not be the same as the first; and at this he seemed to rejoice, and so did Lucy; for "now it would be all his own." He described arches of various curves on the sands; but he had no exact principle or rule to guide him in what he was about; he had a general notion, that the strength of his bridge must depend in some degree on the curve, or the proportion between its span and height; and that the weight and pressure it was to bear on its different parts should be calculated. But how to accomplish all this, or how to choose the best curve for the situation, he did not know. He could be guided only by his eye, by a sort of feeling of proportion; by guess, in short. Lucy assisted him with her feelings and taste, as to which was the prettiest.

"My dear Harry," cried she, "that high pointed arch is very ugly; it will never do: your first bridge was a much prettier curve."

"It must be this height, my dear," said Harry, "because my foundations are to be upon the rock, which is far below the bank. The top of my bridge will be but a little above the level of the path on each side, and when the bridge is built, I shall fill up the space between the sides and the banks with stones and earth, and then level the road over it from the path on each side." He drew the slope for her, and she was satisfied.

But now Harry had to consider the serious affair of a centering for his new arch. His father had said, that if he could make one for himself he might do so, and that he would supply him with boards, if he could tell him exactly what he wanted. Harry fortunately knew what he wanted; but he was ashamed, when he came to write down all that would be necessary, to see how much it was.

“ Twelve thin boards, each four feet long and nine inches wide ; and three boards, six feet long, which are each to be slit into two parts for ties ; and six uprights, of any pieces of rough wood ; and nails, one hundred and a half.”

His father seemed satisfied with these distinct orders, and told him that he should have all that he required. Next morning the carpenter and his boy arrived, bearing the wished-for boards on their shoulders. The moment Harry obtained possession of them, to work he went to make his centering. Flat on the ground he laid four of his four feet boards, two forming each side of the pointed arch, and bringing their upper edges as nearly as he could bring straight lines to something like the curves which he had marked upon the ground. The ends of the boards were lapped over where they joined, and the corners were left projecting on the outside.

“ It is not in the least like an arch yet,” said Lucy.

“ Have patience and you shall see,” said Harry.

With all the decision of a carpenter who knows what he is about, Harry bored holes for his nails, and nailed the pieces together as they lay, three nails in each side joint, and four at the top. Then he nailed one slip, of one of the six feet long boards, across his wooden arch at bottom, to hold it together, and another piece half way up, to brace and strengthen it. Then he sawed off the jutting corners of the boards, which had been left sticking out; and chiselled and planed away parts of the outer edges, to bring them to the curves he wanted. Three such frames or wooden arches he made in the same manner, and exactly of the same size.

Then having determined on the proper breadth for his intended bridge, and having marked it on the ground by two parallel lines, and drawn another midway between them, he placed the frames erect on their lower edge, and exactly upon the three

lines. With ready Lucy's assistance, and some broken branches, he secured them steady and upright, and then proceeded to roof them over with narrow slips of wood, bits of paling, which he had prepared for this purpose. These he nailed across the top of all the three arches, leaving intervals between, of the breadth of each slip; so that when the whole was done, Lucy said that it looked something like the model of the roof of a house.

This day's work completed the centering. Props, wedges, and all were prepared for putting it up, and going on with the masonry. There was no hindrance from the stream: the little rivulet, now sunk to insignificance, ran so quietly down its pebbly bed, that Lucy could scarcely believe it to be the same which had roared so loud, and foamed so high, and had done such mischief in its fury.

The mason-work of Harry's second bridge went on more rapidly than that of his first; his eye and hand having become more expert in the builder's art. "He worked,

and wondered at the work he made;" or rather Lucy wondered at it for him.

"How one improves by practice!" cried she, as she stood by, looking on, while the arch was closing. The key stone was in before they left off work on the fourth day, and the triumphant finishing blow of the mallet given.

But the work of the arch only was finished; much remained to be done to close up the hollow on each side of the bridge, between it and the banks. This was to be filled in with stones and earth, down to the rocky foundation. A heavy job, and heavily they felt it! The three days allowed them of help from the headless man, or, as Lucy now in gratitude for his services called him, the handy man, were passed. They were left to themselves, and obliged to bring the stones and the earth from a distance of many yards, and up a height. The handy man had carried his barrow off, and they had only one wheel-barrow and a basket, if basket it could be called, which was so

infirm that it let through continual dribblings of sand. Lucy, however, mended this with a plaiting of sea-weed and stuffings of moss, and refrained, as Harry was busy, from saying something she could have said, about the sieve of the Danaïdes.

When at last both gulfs were filled up and well trampled, and Harry was spreading gravel on the road over the bridge, Lucy had time to rest, for they had but one shovel; and while he shovelled away, she sat on a large mossy stone, amusing herself with observing a community of ants, whose dwellings had been disturbed by the new works. These emigrants were toiling on in search of new habitations, each with his white load in his forceps, all following the leader, through the moss, and up the stone, to them a rock of perilous height, and scarcely practicable ascent. Once, when a way-worn ant had just reached the summit, a white polished treacherous pebble intervened. He raised one half of his body, so as to be almost





perpendicular, and wabbling about his little head from side to side, deliberated which way he could go, or whether he could go at all. On he went straight up the slippery hill. On the pinnacle of the white pebble, another pinnacle arose of sparkling mica, whose projecting points proved fatal. Striving to reach the first of these, he lost his balance; he fell head over heels, if ants have heels, and at the bottom of the hill lay on his back on the sand, for a moment helpless. But the next instant, being an ant of spirit, he righted himself, resumed his load, and his labour up the hill. Labour in vain: this time a treacherous rush, more treacherous than the pebble, a springy green rush, or branch of sedge, hanging from above, tempted him to trust himself on its smooth green side. But

“ The wind fell a blowing, and set it a going,  
 “ And gave our dear joy a most terrible toss.”

Lucy held out a helping finger, and

raising him up, placed him safely at once upon the very pinnacle he had been so long labouring to attain. Away he ran, as she hoped, perfectly happy. She was particularly pleased with him for this; because she had sometimes helped up ants, who had not seemed in the least obliged to her for her assistance, nor at all happier for it; but, on the contrary, by turning back directly, or not going the way she wished, had provokingly given her to understand, that they would rather have been without her interference. In spite, however, of these incivilities, and of the little disgusts they had at the moment excited, her love for the species had continued. It had, indeed, commenced happily in early childhood, at the time when she and Harry used to watch them making their causeway, and by reading the "Travelled Ant," in "Evenings at Home;" it increased when she read, with her mother, that entertaining paper in the Guardian, well known to young and old; and it had been of late re-

newed with fresh interest, by some curious anecdotes, which her mother had told her from Huber's History of the industrious race.

"Harry," said she, taking up her basket again, "I feel quite rested; I have been very happy looking at these ants. I am sure this has rested me better than if I had been the whole time yawning, and thinking of nothing at all."

"Pray, *can* any body think of nothing at all?" said Harry.

"Let every body answer for themselves," said Lucy. "I think that I have sometimes thought of nothing at all, but I am not sure: yes, indeed, I remember saying to myself, 'now I am thinking of nothing.'"

"But, then, my dear Lucy," said Harry, "your own very words prove you were not thinking of nothing."

"How so?" said Lucy.

"You were thinking, that you were thinking of nothing at all," said Harry.

"I do not understand," said Lucy. "Is not that nonsense, Harry?"

"Oh no, my dear; it is metaphysics," said Harry.

"And what do you mean by metaphysics, my dear?" said Lucy.

"It comes from two Greek words," said Harry.

"But I do not ask you where it comes from," said Lucy, "but what you mean by it?"

"I—" said Harry, a little puzzled, "I mean—I am not sure—I believe metaphysics is the knowledge of our own minds."

"But if we do not know our own minds," said Lucy, "of what is it the knowledge? will you tell me, Harry?"

"I cannot tell you more," said Harry; "I will look for metaphysics in the dictionary, when we have time; but now let us go on with our bridge."

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The striking of the centering was as anxious a moment for Harry, in his second bridge, as it had been in his first; more so indeed, for this arch was all of his own construction. Cautiously he withdrew the wedges, and lowered the centering some inches. A clear space between it and the stone arch appeared, through which Lucy, as she stood low down on the bank of the rivulet, could see, and perceiving that the bridge now stood unsupported, she ran up to Harry rejoicing.

"But you are not satisfied, Harry! Why do you stand so silent? What are you looking at?" said she; "What do you see?"

"I see something that I do not like," replied Harry; "I see some cracks there at the *haunches*, at the sides of the arch."

"Very little cracks," said Lucy.

"Them bees only from the settling of the work, master," said the handy man, who had come to help Harry to take down the centering. "I dare to say it will

crack no more when so be that it bees all settled. It is right good mason work as hands can do, and it will stand as long as the world stands, I dare say."

"I dare say it will," repeated Lucy, glad as we all are, especially on subjects where we are ignorant and anxious, to catch at the support even of a *dare-to-say* from a headless man. Harry, without listening, jumped down to examine his foundations, and came up again with a calm, satisfied look. "My buttments are safe, they cannot be forced away, they cannot be thrust out. We may take down the centering and carry it quite away, carry it to the house; I promised my father to return the boards."

"And I may run home and call papa and mamma to see the bridge standing alone, in all its glory," said Lucy.

She went; but long Harry waited for her return. Once he thought he heard a carriage: too true! a provoking carriage; the first since they had come to Rupert's

Cottage, that had arrived. Lucy returned breathless.

"Mamma advises you, Harry, to come in."

"Does she, indeed?" said Harry, much disappointed; but recollecting what had happened the last time he had neglected a summons of this sort, he immediately turned his back on his bridge, and followed Lucy. She was desirous not to tell him who the visitors were, and he did not care, he said, he did not want to know their names; they must be strangers, and of strangers, one name was to him the same as another. He could have wished to know how many people there were, but Lucy seemed to consider it her duty not to answer this question, and Harry forbore to repeat it. Though he had conquered his original habits of bashfulness, sufficiently to be able to face strangers without much visible repugnance, yet still he felt an inward reluctance. Nevertheless, courageously he turned the lock of

the door, and entered the sitting-room. To his relief, for it must be confessed, notwithstanding his intrepid entrance, it was a relief to him, he found that there was not what he dreaded, a formal circle. There were only two people ; an elderly gentleman, whose countenance was benevolent and sensible, and a lady, seemingly some years younger, of an engaging appearance. Harry liked his first look at both, and Lucy liked their first look at him. He studied them, as he stood beside his mother's chair. He perceived that she and his father liked them ; that they certainly were not new acquaintances, more like old friends. Aiding his remarks on physiognomy by listening to the conversation, he presently discovered, that Rupert's Cottage, and all that it contained, of furniture at least, belonged to them ; that they were the persons who had promised the use of their library ; and that the performance of this promise had been delayed by their absence from home, and by a housekeeper's mistake about a key. The



library, however, was now open, and books and every thing at Digby Castle was at their service. At last the lady's name came out, Lady Digby; and the gentleman's, Sir Rupert Digby.

"Now," thought Lucy, "I know why this is called Rupert's Cottage."

Something was said about the pleasure of a former meeting last summer, and Lucy then whispered to Harry,

"These are the nice shipwreck people, I do believe."

"Nice shipwrecked people! Where were they shipwrecked?" said Harry, "on this coast?"

"No, no, not that I know of; I only mean they were the morning visitors the day of the puddle and pump, who told the story of the shipwreck," said Lucy.

Harry understood by this time what she meant; and much did they both wish, that something would turn the conversation to shipwrecks; but though they got to the sea, it was only for sea-bathing; never farther than to a bathing-house. Then

Sir Rupert and their father began to talk of public affairs : no chance of shipwrecks ! Unexpectedly, Sir Rupert turned to Harry, and in his mild manner, said,

“ I am sure you must wish us away.”

“ No, sir, I do not,” said Harry.

“ Indeed !” said Sir Rupert, smiling.

“ I did, when I first heard the sound of your carriage,” said Harry ; “ but not since I have seen you.”

“ And I know why you wished us away, when you heard the first sound of our wheels,” said Sir Rupert. “ I heard something of a little bridge, which your mother was going out to see, just as we came in. Why should not we all go to look at it ? Pray take us with you : I am interested about it for our own sake, you know. If it should stand through the winter, as I hope it will, next summer, when we come to this cottage for sea-bathing, Lady Digby and I may profit by *the mother's bridge* ; you see I know its name already.”

Lady Digby rose immediately to second

Sir Rupert's proposal. While Lucy went for her mother's bonnet and shawl, Harry ran on before, to set up a red flag, which she had made for him, in its destined place, at the right hand side of the bridge. Knowing what her brother was gone to do, and anxious that he should have time to accomplish his purpose, she rejoiced at every little delay that occurred on their walk. She was glad when her mother stood still to look at the flapping flight of a startled sea-bird; glad when Lady Digby stopped to admire the growth of her favourite myrtle; glad when Sir Rupert slackened his pace, to tell the history of a weeping-birch tree, which he had planted when he was a boy. But by the time this was ended, she began to think Harry must be ready for them, and grew impatient to get on to that turn in the walk where she expected the first sight of the flag of triumph; but no red banner streaming to the wind appeared. She saw several men standing near the bridge, and she ran on to see what they were doing, and what

delayed the hoisting of the flag. When she came nearer the spot, she saw that the people had gathered round the ass-cart. The ass had taken an obstinate fit, to which report said that he was subject, and no power could now get him over the bridge, though he had crossed it once with his empty cart. His leader, Dame Peyton's son, a good-natured boy, who was very fond of him, prayed that he might not be beaten, and undertook to get him on by fair means in time; but the ploughman had become angry, it being now near his dinner time, and had begun to belabour the animal with his oaken stick. Harry stopped his fury, and declared that he would rather the cart never went over his bridge, than that the ass should be so ill used. The ass stood trembling all over, the boy patting him, and cheering him, and engaging for him; and the ploughman resting upon his stick, sulkily muttering, that while the world stood he would never get the obstinate beast over again, without a good cudgel. It was just at this time

that Lucy came up, and Harry put into her hands the flag of triumph, telling her, that they had been obliged to take it down, because they thought it frightened the ass. All manner of coaxing words and ways were now tried on donkey, by little Peyton and Harry, alternately and in conjunction, but all in vain. His fore leg, indeed, he advanced, but farther he would not be moved. By this time Sir Rupert and Lady Digby, and Harry's father and mother had arrived, and as soon as they saw what was going on, or rather what was not going on, they commended Harry's forbearance and patience, and were inclined to think, that it was not, as the ploughman pronounced, *sheer obstinacy* in the ass, but that he might have some good and sufficient reason, or instinct, for his refusal. Harry's father, standing on the bank where he had a view of the arch of the bridge, observed the cracks which had first startled Harry, and which now were more alarming; for, as even Lucy could not help acknowledging to herself,

they had opened wider. In one place, about two feet from the key stone, just at the turn of the arch, there was a crack half an inch open and zigzagging through all the mason work, the mortar giving way and the stones separated.

"This is a bad job, my dear Harry," said his father.

"It is, father," said Harry. "I am glad they did not force the ass over."

"I am glad *you* stopped them, my dear," said his mother.

Sir Rupert Digby now coming up, told Lucy, that he had seen an elephant in India refuse to go over a bridge after he had once put his foot upon it, knowing by his half-reasoning instinct, that it was not strong enough to bear his weight. "No blows or entreaties," he said, "can force or prevail upon an elephant to attempt to go over a bridge that will not bear his weight. The masters, and the engineers and architects, may be mistaken in their calculations, but he never is."

Harry asked his father, what he thought

could now be done to strengthen his bridge, since it seemed it was not strong enough even to bear the ass cart.

“Mamma,” said Lucy, “even if Harry’s bridge will not do for carts or horses, it will do perfectly well for foot passengers, for you and me, mamma, do not you think so? Since it bore the weight of the ass cart once, it would bear mine, I am sure — I should not be afraid — much — to try. I will go over it, shall I, Harry?”

“No, no,” said Harry, catching hold of her, “pray do not.”

“No, I desire you will not, my dear Lucy,” said her father, “till it has been determined whether it is safe or not.”

“And how shall we do that, father?” said Harry, anxiously.

“You shall see, Harry.”

His father ordered, that the ass should be released, and that the cart should be filled with stones. Then he desired two of the men who were standing by to roll this loaded cart by the shafts, as they would a wheelbarrow, up on the bridge, and to

empty it on a spot which he pointed out to them. This they could do without going beyond the sound part.

“Oh papa!” cried Lucy, “it will all come down — what a pity!”

“We must try the bridge fairly, my dear,” said her father, “by putting as much weight on the weakest part as it is ever likely to have to bear. If it stands this, you may safely go over it afterwards. If it fail, Harry will, at least, have the satisfaction of knowing, that no human creature will be hurt or endangered.”

“Thank you, father,” Harry would have said, but the thundering noise of the emptying of the stones forbade. All his soul was in his eyes, and fixed upon the crack. It opened more and more, and a new crack appeared; the sides of the arch, having been pressed inwards by the great weight placed upon the haunches, forced the crown of the arch upwards; and though the key stone, with one or two stones on each side of it, were held together by the mortar, yet the weight of earth on the sides



had pushed most of the others out of their places, and the whole bridge hung in a perilous state!

"Oh! poor Harry's second bridge!" cried Lucy. "Oh mother! are not you sorry for him?"

"Very sorry indeed, Lucy! especially as he bears it so well," said his mother, looking at him, as he stood collected in himself and resigned.

"Thank God nobody has been hurt by it," said he.

"The other side is safe still," said Lucy, "there is a pathway there broad enough; could not that do, and could not this be repaired?"

"No," said her father; "it will be better to make a new one, or to have none at all. At all events, this bridge must not be left in this condition. It might tempt people to go over it, and they might meet with some accident."

"Oh! father, let it be taken down," cried Harry, "I will help to pull it down myself."

"That would be too hard upon you, Harry. It shall be taken down for you," said his father.

He gave the necessary orders, and the work commenced. Lucy turned away, unable to stand the sight of the total demolition of Harry's bridge. Her sympathy comforted him, and he looked gratefully towards her.

"What I think most of, father," said he, "is all the expense you have been at for me, for nothing, all wasted!"

"I do not consider it as wasted, Harry," said his father; for it has amused and employed you, and has taught you something, I hope."

"Certainly," said Harry. "My first bridge taught me to take care of my foundations. You see I did not make the same mistake again, father. There are my foundations safe and sound upon the rock this minute, look at them; if that would do me any good," added he, with a sigh.

"And what have you learned from your second bridge?"

"From my second misfortune I have learned not to put too much weight on my haunches, and to put more on my crown," said Harry.

"Yes, it was all that weight of wall and earth over the sides of the arch that *pippin-squeezed* the keystone up and out," said Lucy. "But, Harry, you know you could not help filling up the hollows between the banks and the arch; you might, to be sure, have made your arch lower."

"Yes, as you said at first, when I drew it on the sand, Lucy, my arch was too high for its breadth, that made it weak; I wish I had taken your hint."

"But I only said so from a sort of feeling," said Lucy; "I had no reason. How much lower would you make it if you were to try again?"

"I do not know," said Harry, colouring as Lucy pronounced the words, try again. "I have not thought of that, I should be

ashamed to ask my father to let me try again, it would be too much."

"I should not think it too much, Harry," said his father, "if it would do you any good; but I do not think it would. You have learned something by your failures, and you have acquired some little practical skill in handling a trowel, and in stone building, but you are not to be a mason."

"I only want to know how to build an arch which will stand," said Harry, "and I cannot bear to give up till I can learn that."

"I like your spirit of perseverance, my young friend," said Sir Rupert.

"So do I," said his father; "but I would not have it wasted."

"When a common mason can build an arch that will stand, why should not I?" said Harry; "for there is the mason's bridge standing now, and heavy coal carts going over it every day; more weight a hundred times it bears, than this single load of stones, which overthrew my poor

weak arch. Why should not I, by practice and trial, succeed?"

"The mason succeeded, because he took advantage of the experience of others, and of the knowledge of men of science. The mason works as a tradesman merely, without knowing the reason or theory of what he does."

"That would not satisfy me," said Harry.

"Then to satisfy yourself, whether you could do any better," said his father, "let me ask you, as Lucy did just now, if you were to try again, what would you do? Build your arch lower, you say, and put more weight on your crown and less on your haunches; but how much lower, how much less weight on one part, how much more on another; can you calculate, can you determine all this? Whenever you can satisfy yourself, Harry, that you can do this, that, in short, you can build a bridge that will stand, and not again disappoint you, I will give you any assistance you want for its construction."

Lucy's eyes brightened.

"Thank you, father, I cannot wish for more," said Harry. "Now I must make out the rules for building arches. They must be in some books," added Harry, looking at Sir Rupert Digby.

"Any books that I have, which can assist you, are at your service," said Sir Rupert. "In a volume of the Edinburgh Encyclopædia, I know there is a highly esteemed essay, both upon the practical and the theoretical parts of bridge-building. I will send it to you as soon as I can, after I go home."

"Thank you, sir," said Harry, joyfully. "I only hope I shall be able to understand it."

"I will not answer for that, Harry," said his father, smiling.

"At any rate," said Sir Rupert, "you will find some things in it that will entertain you both."

Sir Rupert seemed greatly pleased by the good temper with which Harry had borne his disappointment, and by his eagerness to persevere and improve himself.

He talked to him during their walk home, gave him an account of a famous bridge in Wales, the bridge of Llantrissart, which had been built several years ago by a self-instructed mason, who persevered after it had been carried away twice by the mountain torrents ; and at last, the third time, he succeeded, as it is said, by leaving cylindrical holes through the haunches of his bridge to lighten them. Then he talked to him of some other bridges of a new construction, some which have lately been made, others which are now making — suspension bridges ; in these the whole bridge hangs suspended from raised piers.

When Sir Rupert was going away, as he drew up the carriage window, he said to Harry,

“ I shall not forget the book for you, I hope. But if I should, here is one who never forgets any thing that concerns me or my friends, Lady Digby will take care that you have what you wish.”

“ As soon as possible,” said Lady Digby, bending forward from her seat in the carriage, and giving Harry a promissory smile.

Harry calculated, that "as soon as possible," might perhaps be to-morrow; but to his surprise and joy, this evening, as they were going to tea, in came a large parcel, directed to him. It had been brought by Dame Peyton's daughter, who, had been to the castle, and had returned by the *short cut*, along the mountain path. It had been put into her hands, she said, by Lady Digby, her ladyship's own self, who charged her to come up and deliver it directly, not to leave it at the gatehouse till morning. She thought, that is, her ladyship thought, the young gentleman would sleep the better for having it before he went to bed.

"How very kind," cried Lucy; "and what a nice parcel! so neatly tied up too, with a bow knot, and directed in such a pretty hand!"

Harry allowed her the honours, or the pleasures, of unpacking the parcel.

But at this moment the whizzing of the tea urn passing by warned them, that this



was no time for covering the tea-table with paper, packthread, and books.

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So wonderfully was Harry improved, in the power of turning his thoughts from his own speculations to what was going on round about him, that three minutes after he had seated himself at the tea-table, he perceived a new guest, a tame bulfinch. It belonged to the housekeeper, who had the care of this cottage, and having by this time grown familiar with the present inhabitants, Bully sat quite at his ease, perched upon the sugar-tongs, singing in his own praise his evening song of pretty bully ! pretty bully ! bully, bully, bully ! pretty, pretty bully !

Lucy was anxious that his jet black eyes should be admired, and his soft black shining velvet cap and tippet, and his dove-coloured back and flame-coloured or carnation-coloured breast. All these Harry admired to her heart's content,

except that he could not in conscience allow the breast to be flame colour, or carnation colour either. In his secret soul, he thought it more of a brick-dust hue. But this he was aware would not be a pleasing observation, therefore without sacrificing his sincerity, he maintained a prudent silence on this point, and turned as soon as he could from the graces of Bully's person to those of his mind.

"What a confiding little creature he is! Though I am almost a stranger, he does not fly away even from me," said Harry.

As he spoke, he approached nearer and nearer to the bird, holding a bit of cake between his lips. This was rather a bold advance, and so did Bully feel it. When Harry's face came quite close under his parrot beak, Bully hopped sideways a pace or two, and drew himself up in silence, keeping his beak closed; then turning his head many times quickly from side to side, he looked out from his protuberant little eye, suspiciously watching and listening at once. Harry kept his position steadily;

and Bully, directing his eye askance upon him, seemed pleased with his observations, made up his mind, took his part decidedly, hopped upon Harry's wrist, and, to Lucy's delight, began picking the crum of cake from his lips. He then flew away with a fragment of almond, to eat in peace his own way; and he finished it on the hearth-rug, within an inch of the dog, who was lapping his saucer full of milk; into which saucer Bully scrupled not to dip his beak and sip. Harry having never before seen dog and bird on such good terms, pointed them out to Lucy with some surprise. This led to her telling him much more extraordinary instances, some of which she had read, and others which she had heard, of friendships formed between creatures, usually supposed to be natural enemies. At one anecdote, though from high authority\*, Harry demurred. A bird had been brought up along with a certain cat, with whom it eat, drank, and lived upon the

\* MISS Aikin's "Juvenile Correspondence."

best terms, till one day the cat suddenly flew at the bird, caught it up in her mouth, and carried it out of the room—to eat it, as every body thought, and as Harry could easily have believed; but it seems that puss carried the bird off to protect it from another cat, a stranger, who had entered the room at the instant, and from whose evil propensities, of which she was well aware, she had thus saved her little friend and *protégé*.

“And can you believe this,” said Harry, “of a cat? I could believe it of a faithful dog, but not of a selfish, treacherous cat!”

Harry had, as Lucy observed, taken up the common prejudice, that cats are all false and treacherous. Her experience had led her to form a better opinion of the feline race; and she pleaded for them, that this anecdote was too well attested to be doubted. This led to many other anecdotes, pro and con; and to some observations upon evidence, and the reasons why we should or should not believe ex-

traordinary facts or assertions. The conversation at last interested Harry so much, that he really forgot his arches and the Encyclopædia, till the tea-things were actually out of the room, and the last polishing rub given to the tea-table.

Then he returned to the book with fresh eagerness, and Lucy followed with fresh complaisance. Looking over his shoulder, she was, however, daunted by the sight of a number of  $x$ 's and  $y$ 's. "I am afraid I shall never understand any of this," said she.

"Nor I neither, I am afraid," said Harry.

"Stay, Harry, do not turn over this leaf; here is something I can understand, and a very curious fact too, that neither the Persians nor the Greeks knew how to build arches; at least, that no trace can be found of arches in any of their buildings. This book say, sthat it is not ascertained, even yet, to what people we owe the invention. The Romans were the first who brought it into general use in their

aqueducts for conveying water to their large cities, and in their bridges over great rivers, and in their magnificent temples.

Harry regretted that the name of the man who first built an arch had not been preserved : then, turning to his father, he asked, if he thought that it had been regularly invented, or only discovered by accident? His father said he was inclined to think, that this useful discovery had been the result of accident, observation, and invention combined.

" Yes," said Harry, " perhaps in this way ; a person may have seen some old building that had given way, where the stones might have so fallen upon each other, and so wedged, one between the other, as to give the first notion of the manner in which an arch is supported. I remember," continued Harry, " taking notice of something of this sort in a broken wall : I saw a heavy stone, which had fallen so as to wedge itself between three or four others, and made, as it were, the key stone of an arch ; I think such an

accident might have often happened, and might have given the first idea to other people. But to be sure I had seen an arch before, and unless I had, I should never probably have taken notice of the way in which those stones had wedged themselves."

"But," resumed Lucy, pursuing her own thoughts, "how very common arches have become in these days; even common uneducated masons can build them."

"Yes, but only by imitation: by a model, or from a drawing or plan," said Harry.

"And though we made some mistakes," continued Lucy, "yet is not it curious, mamma, that, even at his age, Harry can do, in some way or other, what neither the Persians nor Greeks could do in any way."

"But, Lucy," interrupted Harry, "you must consider, that, even as far as I know, I have learned it all from other people: I did not invent it. If I had invented an arch, then indeed you might feel proud."

"Stay, stay! do not turn over the leaf yet," cried Lucy, "here is something I want to see about a bridge of rushes, in South America, over a river, between eighty and a hundred yards in breadth. It is made by laying bundles of rushes on four very large cables, stretched across, and made of a kind of grass. The army of one of the *Incas* was passed over this bridge; and it was of such prodigious use, that a law was made by the Inca, that it should be repaired every six months. And here is an account of another kind of bridge in South America, called a *Tarabita*. It is made of a single rope of thongs of an ox's hide; or, as they call it, *Bujuco*. This rope is also stretched across the river, and is fastened at each end to strong posts on the banks. From this is hung a kind of hammock, just large enough for a man to sit in; a small rope is tied to the hammock, and men standing on the opposite shore, pull the passenger in his hammock along the cable.

"But, mamma, only think of the poor



mules! When a mule is to be carried over, they put girths under his body, and sling him up to a piece of wood, which slides along the great rope, and there he hangs till pulled to the other side. The first time a mule is lugged over in this way, he makes a prodigious kicking and flinging during the passage; and I am sure I do not wonder at it. But in time these docile patient creatures come of themselves to be slung, and when used to it they never make the least motion during the passage."

Lucy's father told her, that in this country, horses are every day slung in a similar manner, to be put into ships; and that rope bridges, on the same principle as the Tarabita, have been made in India as well as in South America, and are very useful in places where arches cannot be built."

"Do not you think, papa," said Lucy, "that the first idea of the sort of bridge Sir Rupert Digby was describing to Harry, was taken from the Tarabita?"

"Very likely, my dear," answered her

father; but I did not hear Sir Rupert describing the bridge; tell me what he said."

"I forgot that you were not walking with us, papa," said Lucy; "it was a *suspension bridge*, as he called it, and —"

"My dear Lucy," interrupted Harry, "pray do not go on to the suspension bridge yet, because I want to talk to papa about it myself; by and by, if I find that I cannot manage my arch: but let me settle that first. Now if you have done with the Tarabita, let me have the book quite to myself."

Lucy immediately surrendered it; saying at the same time, "If you meet with any thing more that is entertaining, any thing more that I can understand, will you call me, or will you read it to me, Harry? I shall be only winding a skein of silk for mamma." After a short silence, Harry called to Lucy, "Here is a curious fact about the Chinese manner of building arches. Each stone, which is from five to ten feet long, is cut so as to form a segment, that is a

portion of the arch, and there is no key-stone. Ribs of wood are sometimes fitted to the convexity of this arch, and are bolted through the stones by iron bars. This fact, of their doing without a key-stone, reminds me of what my father said, that there is no mystery in the key-stone. He laughed at me for the rout we made about it, as if there was something magical in it. He said that each stone might be considered as a key-stone, if it were put in last; but that it was more convenient to load the wooden centres equably, by working from the buttments up to the middle or crown of the arch."

Lucy returned to her skein of silk, and Harry, with his elbows on the table, and his hands over his ears, gave himself up entirely to Part the First of the Theory of Bridges.

In vain, utterly in vain. At last a heavy sigh, approaching to a groan, was heard from him.

"Father, I cannot make out what I want to know. I think you told me, that when

an arch is in equilibrium; it will bear almost any weight that can be put upon it; therefore I was very anxious to understand, first, what is meant by an arch being in equilibrium; and then I wanted to find out how to make it so. You told me, that an arch is in equilibrium, when the materials of which it is built are so placed, that the pressure of their weight should be equal in all their parts. I understood, that when the haunches were not too heavy, they would not press in, as they did in my poor bridge, and squeeze up the crown. I thought I understood clearly what you said, that as long as the buttments are secure, and as long as no part of the arch changes its form, by being pressed up or down by the weight, so long and no longer its strength remains."

"So far; so good, Harry," said his father. "You understand so far well."

"Ah! father, but now comes the worst, the difficulty; *how* to build an arch in equilibrium. I said to myself, there must be rules for it, since people do it every day, and they must be printed; probably

in this best of essays on the theory and the practice of bridges. And so here are all the rules before my eyes; but the misfortune is I cannot understand them."

"Why, Harry? Why cannot you understand them?" said his father.

"Because they are all full of algebra and mathematics, and a number of terms which I do not understand. Cycloids, hyperbolas, intrados, extrados, and curves of equilibration, of all which I know nothing. Then suddenly I thought I should see the whole plainly at once, father, where it says,

" 'The stones or sections of an arch, being of a wedge-like form, have their tendency to descend opposed by the pressure which their sides sustain from the similar tendency of the adjoining sections; should this pressure be too small, the stone will descend; should the pressure be too great, the stone will be forced upwards.' "

"Now the very thing that I want to know for my bridge is, how to make the

pressure just right," continued Harry :  
 " but when I hoped I had just got at it,  
 all was lost to me again in a crowd of  
*a b*'s, *x* and *y*'s, and sines and tangents,  
 and successive angles of inclination,  
 and then it ends with — ' Let us go back  
 to the geometrical construction,' and so  
 there I am left as wise as ever, or as fool-  
 ish ; for I cannot get on one single step  
 further."

" For want of what, Harry?" said his  
 father.

" For want of geometry, father : for want  
 of knowing something more of mathe-  
 matics. But could not you, father, put the  
 rules for me in plain words, without alge-  
 bra or mathematics?"

" Impossible, my boy ; without your un-  
 derstanding mathematics, I cannot explain  
 further to you. It is put there as clearly  
 as it is possible ; and it is not the fault of  
 the explainer if you cannot understand it.  
 But consider, Harry, this was not written  
 for youngsters like you ; but for men of

science, who have acquired all the necessary previous knowledge."

"Men of science," repeated Harry, thoughtfully; "those men of science must, at some time of their lives, when they were youngsters, father, have been as I am now, I suppose; and I may be, if I work hard and get the knowledge, as they are now. Then I *will* learn mathematics. There is nothing else for it. I will set about it in earnest. The want of this knowledge meets me everywhere, and stops me short in the most provoking manner. I remember in the dock-yard, about the shape of the ship, and the sails and sailing, I was told perpetually, you cannot understand that for want of mathematics. And now I must give up building my arch, all for want of mathematics."

"Give up building the arch!" cried Lucy, "then you will give it up, after all."

"I must," said Harry.

"I thought you would never give up,

“Harry,” said Lucy. “I thought you who have so much perseverance and resolution, would try again and again. Perseverance against Fortune, you know.”

“Yes, if I could by perseverance be sure of succeeding at last,” said Harry, “or even have a good chance of it: but it would not be resolution, would it, father? It would only be obstinacy to persist in doing the same thing over again, without knowing how to do it better.”

“No,” answered his father, “it would not be obstinacy, but it would be senseless and useless perseverance. You have come exactly to the conviction to which I knew your two experiments and your good sense would bring you, that mathematics are so necessary, not only to bridge-building, but to almost all the useful arts, as well as sciences, that you can make but little progress without this knowledge. Having found yourself stopped short for want of it, in an affair on which your heart was set, and which seemed merely a handicraft art, you feel this come home both to your



business and your pleasure. So now put by the Encyclopædia for to-night; go to bed, and think no more of arches and bridges, nor even of mathematics, till to-morrow.

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NEXT morning Lucy met Harry with a melancholy countenance, and in a mournful tone said, "My dear Harry, all the time you are learning mathematics, are we to have no bridge? Is it all come to this at last?"

"My dear Lucy, do not be in such terrible despair," said Harry. "Let us consider about the suspension bridge, of which Sir Rupert was talking."

"Oh! yes," cried Lucy, "I was in hopes that we could make a suspension bridge. How was it Sir Rupert described it, can you recollect, Harry?"

"That bridge which he described," said Harry, "was formed of huge iron chains, hanging across the river, from high piers built of solid masonry, on each bank.

These chains passed over the top of the piers, and down to the ground, and the ends were secured fast in the solid rock. If these fastenings do not give way, from the weight of the arch of chains pulling over the top of the piers, and if no links in the chains themselves break, the bridge suspended from that arch, with any proper weight that can be laid upon it, or may pass over it, would be safe, and the bridge would last for ever."

"So in this bridge, then," said Lucy, "the arch is turned upside down."

"Yes," said Harry, "the arch is inverted. And there is one great advantage for me in this, which is what I want to come to; that an arch which hangs, saves all the difficulty of construction to me. It hangs by its own weight, like a chain, and gravity settles the matter for me, and makes it take the right shape. Look out of the window, Lucy, at the curve made by that chain in the fence, between two of those wooden posts; that is called the *catenary* curve; from *catena*, a chain. I have just

been reading about it. Now suppose it stiffened in its present shape, and inverted, and then set upon the ground like an arch, it would make a very strong bridge, if it had good buttments. But hanging down it will do our business."

"Will it?" said Lucy. "I am glad of it; but we have no chains, and you would be obliged to build up great pieces of solid wall, piers as you called them, and then you must ask for the mason's man again, and there would be all that trouble over again. I will tell you what would do instead, without any trouble. There are two trees on the opposite banks of our river, Harry, a little higher up the hill than our bridge is."

"*Was*, not *is*," said Harry.

"*Was*," repeated Lucy, with a sigh. "But these trees are in a beautiful place, and they are good large trees, with stout stems. Now from one to the other of these, could we not hang, instead of great heavy chains, strong ropes, and fasten them securely round the trunks of the

trees? Do you know the place that I mean, where the two trees are?"

"I know the place very well," said Harry, "and an excellent place it is, about eight feet across from bank to bank, and the trees about sixteen feet asunder. And yours is a very good notion of making use of these trees to hang our suspension bridge from: but when you have hung your ropes, how will you get on? And tell me, do you mean to let them fall down arch-ways, or to stretch them tight and hang a basket to them, and so pull the passengers over by a rope fastened to the basket, in the Tarabita way?"

"No, no," said Lucy, "I should not like to go in the basket that way, nor would mamma, I am sure. Do not Tarabita us over. Pray, Harry, think of some better way."

"I will tell you how I would do it," said Harry. "But, in the first place, why should we use ropes? Why not wire? There is an inconvenience in ropes which

there is not in wire. Ropes would stretch; tie them or fasten them in what way you would to your trees, the arch of rope would stretch or shrink."

"Yes, with the dryness and damp, if with nothing else," said Lucy: "therefore instead of rope let us have wire. But recollect, Harry, that if wire does not stretch, it may crack and break."

"That is true," said Harry; "but we must have strong wire, such as fences are made of; and, you know, we might easily try the strength of the wire first, by hanging weights to it."

"And where shall we get such wire, and enough of it?" said Lucy.

"That is another affair," said Harry.

"Well," said Lucy, "suppose - your wire were fastened round the two trees, and hanging across from bank to bank."

"Yes," said Harry, "fastened to the trees, at about the height of six feet from the ground, and the wire passed round the body of the trees, and two lengths of

wire stretching across, with the thickness of the trunk of the tree between them : both wires hanging equally loose."

" But it would not fall into the shape of an arch," because wire is *stiffish*, you know ; and I am afraid that its own mere weight would not be sufficient to bring it to the curve in which a heavy chain would fall."

" Very true," said Harry, " but I think it will take that curve when I hang some weight upon it ; the weight of my bridge ; you shall see."

" Show me that," said Lucy, " for the bridge is what I want to come to. Of what is that to be made, and how ?

" Of two deal boards," said Harry, " and they must be joined together endways, by nailing a short piece of board to them both underneath ; then these two boards would be long enough, not only to reach across, from bank to bank, but also to lie firmly on the ground at each end."

" But that is only a plank bridge, thrown across in the old way," murmured Lucy.

" Stay a bit," said Harry, " and you

shall see something new. I have not finished what I was going to say, and I must go back one step. I forgot to tell you, that, before I laid these boards down, I would nail across their under side five or six slips of wood, somewhat like those with which you may recollect we connected the top of the centerings, but stronger. The ends of these slips of wood are to project beyond the edges of the board, suppose a few inches at each side : then I would lay down the board as before, and to each end of all these slips of wood I would fasten a piece of wire, but of a smaller kind than that of which my arches are to be made. I would then carry these pieces of wire, which Sir Rupert called *stirrups*, straight up from the ends of the cross slips, where they are thus fastened, to the two great hanging wires over head, and I would fasten them to these wires tightly. Then, you see, we should have six upright wires on one side, and six on the other ; and you would be able to walk on your board between them. Now the weight of

this board, and of whatever comes upon it, will, I think, draw the two great wires into the proper arch shape: and then we shall have the strength of an inverted arch to support our plank-bridge. Just the same as if it were an arch on the ground, with its back upwards, and a road over it."

"Excellent," said Lucy, "I see it all, and I shall be able to walk safely between those up and down wires, which, besides supporting the board, and hindering it from swagging down in the middle, and in all its great bending length, will also form a nice sort of fence, to prevent my feeling giddy. Those upright wires would form a sort of balustrade, that is the word, and altogether I think the thing would look very pretty, and I wish we could make it. If we had but the wire!—But then, my dear Harry," said Lucy, after a short pause, "this bridge will do only for human creatures. The ass and the ass-cart cannot go over it."



"No," said Harry, we must give that up."

"So we must, and so we will," said Lucy; "and after all, it is not much trouble to the ass to go round the other way. It was only for the glory of the thing I wanted him to go over your bridge, and all that can be said is, that yours, Harry, is not the *asses bridge*."

"Thank you," said Harry, accepting even of a pun willingly and gratefully, when in due season.

Next morning came Sir Rupert Digby, and he was of great use to Harry. Luckily he had a supply of all the things which were wanted for this bridge. He had some strong wire, of an eighth of an inch thick, and some of a tenth; these had been procured for the purpose of making invisible fences, to keep the hares from Lady Digby's carnation beds, and sufficient had remained for Harry's bridge. Two long deal boards he also supplied, besides a short piece for uniting them;

and some old paling furnished the cross pieces.

Thus happily provided with all he wanted, Harry went to work ; and in the course of a week's labouring with wood and wire, he successfully accomplished his suspension-bridge, according to the plan he and Lucy had formed together. The arch hung from tree to tree, in a beautiful spot, as, without exaggeration, Lucy had described it; and across from bank to bank stretched the bridge, supported by its six wires from the arch above. The mother went over the mother's bridge the day it was finished, without once catching flounce or petticoat in the wires. Indeed, after having crossed it, complaisantly, twice for the honour of the architects, she actually crossed and recrossed it a third time, purely for her own satisfaction. As to the number of times which Lucy crossed and re-crossed the mother's bridge this day, it must not be named, for it would pass all human, or all grown-up powers of belief.

The historian has been minute, perhaps,

even to tediousness, in the detail of the construction of this suspension bridge, in the hope that it may prove a pleasure to some future young workmen. For their encouragement it should be noted, that this is not a theoretic, but a practical bridge. Nothing is here set down but what has been really accomplished by a boy under twelve years of age. It has been said, as an incentive to enterprise, that whatever man has done, man may do again. And it is equally true, that whatever boy has done, boy may do.

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ONE day, Harry and Lucy were with their mother, at her comfortable seat, she working, Lucy reading to her, and Harry making a kite; he looked up to see which way the wind was, and he saw Sir Rupert Digby coming down the mountain towards them. Away went books and work, the kite and his tail were cleared off the ground, and Harry and Lucy ran to meet their friend. He had a long pole in his

hand, pointed with iron, which he used as a walking stick. This Harry and Lucy instantly supposed must be one of those used by the peasants on Mount Pilate, of whom they well remembered the account which their mother had formerly read to them. The long disputed question between them, as to the manner in which these poles were held by the people, who used them in descending steep mountains, was now settled beyond a doubt, by Sir Rupert's evidence, and by his showing them the method. Lucy found, that it was exactly the way which Harry had understood from the description, and shown to her. Lucy walked, or attempted to walk, all the rest of the way, down the steepest part of the path, with Sir Rupert's pole ; but, far from its being of use, she slipped ten times more than usual, from want of understanding the practice as well as the theory of wielding it. After they were fairly on flat ground, and had passed Harry's bridge, paying due and never-failing toll of admiration, Lucy began to ask Sir Rupert questions

about Mount Pilate, whether he had ever ascended it when he was in Switzerland, and whether he had seen or heard any thing of the twelve children, who once lived there in a hut, which they had built for themselves, with a dog to guard them. Sir Rupert had ascended Mount Pilate, but of the twelve children, their hut, and their dog, he could give no information. Indeed, had the individuals for whom Lucy was inquiring been living and forthcoming, they must, by this time, have been about eighty or ninety years of age. To make amends, if possible, for his ignorance about these children, he gave Lucy a description of a storm, which came on one day when he was in a boat on the Lake of Lucerne, so suddenly, and with such violence, that it was all the experienced boatmen could do, to get into a little bay in time to escape the danger of being upset. The lightning was more brilliant and frequent than any he had ever seen in England, and the thunder reverberating from the mountains more deep-toned and sublime. But the

circumstance which remained in his mind, as most characteristic and picturesque, was the sudden gathering of an immense body of black cloud, which covered the blue sky almost instantaneously, and descending from the summit of Mount Pilate to its base on the edge of the lake, hid the whole of that mountain as completely as if it had not been in existence. In less than ten minutes, this black, dense mass of clouds, which had advanced upon the blue waves, opened towards the middle, and, like a curtain drawn back in vast folds, passed away on each side, revealing the base of the mountain; the divided mass then quickly rolled upwards, like enormous volumes of smoke, and vanishing from the summit, left it clear. In a few moments, no trace of cloud was to be seen; the sky was blue, the sun shining brightly, and the whole expanse of the lake placid and unruffled as if no storm had ever been.

To interest Harry still more about Mount Pilate, Sir Rupert promised to send him an account of an extraordinary mechanical

work, which existed there a few years ago, called the slide of Alpnach.

"Could not you give me some idea of it now, sir?" said Harry; "I dare say we should understand it as well, or better, from your description, than from the book."

"I will endeavour to explain it," said Sir Rupert, "as you wish it; but in the book, to which I allude, there is a more clear and exact description, than I can hope to give. It is written by one who saw the work," continued he, turning to Harry's father, "by our great, our amiable, our ever-to-be-regretted friend, Professor Playfair.

"First, Harry, I should tell you the purpose for which it was made. On the south side of Mount Pilate, there were great forests of spruce fir; and at the time of which I am speaking, a great deal of that timber was necessary for ship building. These forests were, however, in a situation which seemed almost inaccessible, such was the steepness and ruggedness of that side of the mountain. It had rarely been visited but by the hunters of the chamois

or wild goat, and they gave information of the great size of these trees and of the extent of the forests. There these trees had stood for ages useless, and there they might have stood useless to this day, but for the enterprize and skill of a German engineer, of the name of *Rupp*. His spirit of inquiry being roused by the accounts of the chamois hunters, he made his way up by their paths, surveyed the forests, and formed the bold project of purchasing and cutting down the trees, and constructing, with some of the bodies of the trees themselves, a singular kind of wooden road, or trough, down which others fit for ship building could be sent headlong into the lake below, which fortunately came to the very foot of the mountain. When once upon the lake, they were to be made into rafts, and, without the aid of ships or boats to carry them, they were to be floated down the lake. It was proposed, that from thence they should be conveyed, by a very rapid stream called the Reuss, into the river Aar, and thence into the Rhine, down



which these rafts could be easily navigated to Holland, where the timber was wanted. They might further be transported into the German ocean, where they could be conveyed to whatever port was desired.

“Forgive me,” said Sir Rupert, smiling, as he looked at Lucy, “for troubling you with the German ocean, and the Rhine, and the Aar, and the Reuss, and with all my geography; it is not for the sake of displaying it, nor for the purpose of trying your patience; but I mention their names, because I am sure that you will look for them on your map, and you will understand the difficulty, and find the whole thing much better fixed in your memory by knowing all the places and distances distinctly. Besides, you will be better able to explain it to others, than if you could only say, There was a forest on some mountain, whose name I don’t know; the trees were thrown down into a lake, whose name I can’t recollect, and sent by a rapid stream, whose name I never knew, into another, whose name I forget, and so on, to a great

river, whose name I ought to remember, but cannot, and so into an ocean, which has a particular name, if I could recollect it, till at last, some how, these rafts got to wherever they were wanted, but where that was I cannot well tell."

Lucy half laughed and looked half ashamed, for she said she had often felt almost as much at a loss in repeating things she had heard, for want of remembering the geography of the story.

"But now, sir, for the slide," said Harry. "You said, I think, that it was a kind of trough made of the bodies of trees; did you mean the mere trunks, without their being sawed up into boards?"

"The trunks of the trees," replied Sir Rupert, "just roughly squared with the axe. Three trees so prepared, and laid side by side, formed the bottom; another set formed each of the sides, and all strongly fastened together, composed this enormous trough, which was about three or four feet deep, and about six feet wide at the top. It extended to a length of

more than eight miles, from the place where the forest stood on the side of the mountain, to the lake below. Each tree that was to be sent down had its branches lopped off, its bark stripped, and its outer surface made tolerably smooth. Men were stationed all the way down, at about half a mile distance from each other, who were to give telegraphic signals, with a large board like a door, which they set up when all was right and all ready to begin, and lowered when any thing was wrong. These signals were communicated from man to man, so that in a few seconds the intelligence was known all along the line that a tree was to be launched. The tree roaring louder and louder, as it flew down the slide, soon announced itself, and, as Playfair describes it, came in sight at perhaps half a mile distance, and in one instant after shot past with the noise of thunder and the rapidity of lightning."

"How I should like to have seen it," said Harry. "Sir, did not you say that Mr. Playfair himself saw a tree go down?"

“Yes, he and his young nephew saw five trees descend. One of them a spruce fir a hundred feet long, and four feet diameter at the lower end, which was always launched foremost into the trough. After the telegraphic signals had been repeated up the line again, another tree followed. Each was about six minutes in descending along a distance of more than eight miles. In some places the route was not straight, but somewhat circuitous, and in others almost horizontal, though the average declivity was about one foot in seventeen. Harry, I hope I am exact enough to please you.”

“And to instruct me too,” said Harry, “for I could not tell how wonderful the thing really was without knowing all this.”

“Did Mr. Playfair and his nephew stand at the top or the bottom of the hill, sir?” said Lucy; “did they look down upon the falling trees, or up the hill to them as they were descending?”

“Up to them,” said Sir Rupert. “They stationed themselves near the bottom of

the descent, and close to the edge of the slide, so that they might see the trees projected into the lake. Their guide, however, did not relish this amusement; he hid himself behind a tree, where for his comfort the engineer, Mr. Rupp, told him he was not in the least degree safer than they were. The ground where they stood had but a very slight declivity, yet the astonishing velocity with which the tree passed, and the force with which it seemed to shake the trough, were, Mr. Playfair says, altogether formidable. You, Harry, who are a mechanic, must be aware, that with bodies of such weight, descending with such accelerated rapidity, there would be great danger if any sudden check occurred; but so judicious were the signals, and all the precautions taken by this engineer, that during the whole time the slide of Alpnach was in use, very few accidents happened. The enterprize, begun and completed so as to be fit for use in the course of a few months, succeeded entirely, and rewarded, I believe with

fortune, I am sure with reputation, the ingenious and courageous engineer by whom it was planned and executed in defiance of all the prophecies against him. The learned, as well as the unlearned, when first they heard of it, condemned the attempt as rash and absurd. Some set to work with calculations, and proved, as they thought, and I own as I should have thought, that the friction would be so great, that no tree could ever slide down, but that it must wedge itself and stick in the trough. Others imagined they foresaw a far greater danger, from the rapidity of the motion, and predicted that the trough would take fire."

"That is what I should have been most afraid of," said Harry.

"And your fear would have been rational and just," said Sir Rupert. "This must have happened, but for a certain precaution, which effectually counteracted the danger. Can you guess what that precaution was, Harry?"

Harry answered, that perhaps water might have been let into the trough.

"Exactly so, Harry," said Sir Rupert; the mountain streams were in several places conveyed over the edges, and running along the trough, kept it constantly moist."

After this, Sir Rupert and Harry's father began to talk to each other about some curious circumstances concerning the Slide of Alpnach, which have puzzled men of science and philosophers. Harry did not comprehend all they were saying; but his curiosity was often excited by what little he did understand.

His father said, that he could better have conceived the possibility of the safe descent of the trees on this wooden road, if it had been in one straight uninterrupted line; but there were, as it appeared, bends in the road. He should have judged beforehand that a descending body of such *momentum* (weight and velocity) could not have had the direction of its motion

changed as suddenly at these turns as would be necessary, and he should have thought, that either the side of the trough against which the tree would strike at the bend must have been broken, or more probably that the tree would by its acquired velocity have bolted in a straight line over the side of the trough. Sir Rupert said, that he should have thought the same, beforehand; and both agreed, that the facts ascertained by the unexpected success of this Slide of Alpnach, opened new views and new questions of philosophical discussion, as the result was contrary to some of the generally received opinions of mechanics, respecting friction especially.

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“HARRY, my dear,” said Lucy, “what were you doing this morning when I passed by without your speaking, and when you were drawing something upon a slate?”

“I was drawing,” answered Harry, “the roof of a house for Dame Peyton. The other day I heard her talking to the wood-



man about a new roof, which she is going to have made, and I did not think the plan they proposed was a good one. Sir Rupert Digby has given me leave, indeed he has desired me to try whether I can make one that will do better, and he will be so kind as to give whatever timber is necessary; and papa will look at my plan, and hear what the woodman proposed, and determine which will do best."

Harry had long ago learned the principles of roofing, from a little model which his father had made for him. It took to pieces, and could be put together again, and the names of all the parts were written upon them, so that both their names and uses were familiar to him. Besides, he had since seen in large what he had learned in small. He had observed the manner in which his father had made or repaired the roofs of his tenants' houses, so that he had now only to apply what he already knew to his present purpose in making the plan for Dame Peyton's roof.

Lucy begged of him to let her see it, and

to explain it to her before he showed it to his father, that she might understand what he was about. Harry said he would explain it to her with pleasure ; but he thought it would be best, before he showed her his drawing, to give her some general notion of the principles of roofing, or else she could not understand whether his plan was right or wrong, or good or bad.

Lucy said that she should like this very much, if it was not very difficult to understand.

“ Not in the least,” said he ; “ my father explained it to me, and I will try and do the same for you. I will begin, as I remember he did, by settling first the thing to be done. In order to have a good roof, it is necessary that it should be so constructed as to enable it to bear not only its own weight, but the weight of the thatch, or tiles, or slates with which it is to be covered. It must be made so as to stand steadily, and so as not to push out the walls of the house. It must be fastened

on the house, so that it may not be blown away by the wind; and it must slope, so as to carry off the water, which falls when it rains or snows. Besides all this, a good roof should be as light as may be consistent with strength, not only because it should press as little as possible on the walls of the house, but because there should be no waste of timber, timber being sometimes scarce; and even in countries where there is plenty, it would only weaken the work by useless weight, to employ more timber than is necessary for strength."

"Yes, I understand very clearly the thing to be done," said Lucy; "now for the way of doing it. But you said one thing, Harry, which I think was not quite correct; you said roofs must slope to let off the water, now I have seen flat roofs."

"It is true," said Harry, "some roofs are flat; but *in general*, as I should have said, roofs are made to slope from the middle, down to the front and to the back; not only to let the water run off,

but for the strength of the roof, as I will explain by and by. Some slope more, you know, and some less."

"Yes," said Lucy, "and some are ugly and some are pretty, I hope that is to be considered in your good roof."

"Yes," said Harry, "and some are strong and some are weak; that is to be considered first. Under the thatch, slates, tiles, or whatever the outside of the roof is covered with, you know, Lucy, there must be some sort of frame-work, which supports this covering. Have you any recollection of the look of that frame-work? You have, I know, often seen the roofs of houses before they were slated, have not you?"

"Very often," said Lucy; "yet I have only a general notion of a sort of wooden work, as you say, sloping both ways from the middle, with some sort of triangular shaped frames underneath, and straight pieces of wood nailed across these."

"That is the general look, and I will explain the use of those triangular frames," said Harry.

"The use I think" said Lucy, "was to support the weight of the pieces of wood to which the slates were to be fastened."

"But why should these frames be triangular," said Harry, "do you know? Would they do as well if they were not that shape?"

Lucy said she did not know; she had a feeling that they would not be so strong, but she could not exactly give a reason for it.

"Then I will show you," said Harry, "for all roofing depends upon this; and if you once understand this well, all the rest is easy. Suppose that this frame was not a triangle—suppose the base, or piece that goes across, taken away, and the two sloping sides placed on the walls of a house, with their upper ends leaning against each other, what do you think would happen?" said Harry.

"They would hardly stand, I think," said Lucy, "unless they were fastened together at top, and fastened to the wall in

some way at the bottom. They would slip, like cards which we set up that way in building card houses."

"Very well," said Harry, "so they would. Now suppose them fastened together at top, what would happen when a great weight was put upon them?"

"Still they would be pressed out at bottom," said Lucy.

"Now how will you hinder that?" said Harry.

"Fasten them well to the walls on each side," said Lucy.

"But," said Harry, "the weight must still tend to press them out at bottom; and if they are fastened to the walls, then the walls must be pressed out also. Look at this ruler of mine," continued he, opening a carpenter's rule, and setting it up like a sloping roof upon two books; "these two books may stand for walls, and you see they are pushed down when I press my hands upon the roof."

"I understand," said Lucy. "Now I perceive the use of that piece of wood at

bottom, that base of the triangular frame which you took away; we must put it back again: I see it is the great, the only strength of the whole. The ends of the two sloping pieces must be well fastened to that; they are then held together, and cannot be pressed out at bottom, and the weight on them will not then push out the walls."

"But now before we go on any further," said Harry, "let me tell you the names of the different parts, or we shall get into confusion. A roof made in this manner is called a framed roof, or a *trussed* roof. The two sloping pieces of this frame are called *principal rafters*."

"I have heard the tenants in talking to papa about roofs ask for a pair of principals," said Lucy; "now I am glad to know what is meant, and what they wanted."

"And this piece," continued Harry, "which goes across at the bottom, and forms the base of the triangle, holding, or, as we say, tying it together, is called the *girder*, or *tie-beam*: sometimes this piece

is not placed at the bottom, but higher up, and then it is called the *collar-beam*."

"The whole must be much weaker when it is higher up than when it is quite at the bottom, I think," said Lucy. "I would rather have a tie-beam than a collar-beam, if I were to have a roof."

"You are very right in that," said Harry. "But let us go on. Such frames as these are sufficient for a small roof, like Dame Peyton's. Six or seven of these, I believe, there were in her old roof; they were all fastened together at top by a long piece of wood called a *ridge-pole*, and at bottom they were secured to flat pieces of wood on the top of the walls of the house, which are called *wall-plates*; over these were laid, about a foot asunder, slender but straight branches of trees, about the thickness of my wrist. They lie across from frame to frame horizontally, and sometimes over these they lay hurdles to support the thatch."

"I think Dame Peyton's had hurdles," said Lucy. "I recollect looking up one





day at the loft. I remember the look of the hurdles, and the thatch above. All that you have told me about a roof, Harry, is not nearly as difficult as I expected; it is really very simple and easy."

"Then this is all that is necessary for the roof of any small house," said Harry, "where the width or span is not above fifteen or sixteen feet, like Dame Peyton's."

"Was there any particular fault in her roof except old age?" said Lucy.

"Yes," said Harry, "there was; a fault which prevented it from lasting to old age. It was not at all old, but weak. It had the very fault you said you should not like to have in the roof of your house; instead of having girders, it had only collar-beams, which were placed so high up that they had not sufficient strength to prevent the principal rafters from spreading out."

"How foolish the man must have been who built it in that way," said Lucy; "or do you think he had any reason for it?"

"He did it, I suppose, to give more room over head in the loft," said Harry.

"You will not do so," said Lucy. "But except that you will have girders, will your roof be the same as the old one?"

"No," answered Harry, "mine must be different in other ways, and I will tell you why. The span of Dame Peyton's new roof must be considerably larger than that of her old one. You know the shed which goes along the whole length of the back of her house? It has a lower roof, that slopes from the back wall—a *pent-house* roof; that roof is to be taken down, as it lets in the wet. She will have the wall of that shed raised, to make it even with the walls of the house; and she is determined to take away the present back wall of the house, which divides it from the shed."

"Then the new roof is to cover the whole," said Lucy. "I am glad of it. Now show me your plan."

"First answer me one question," said Harry, "and tell me what you would do yourself. The span you know is to be five feet more than that of her old roof;

then the girder must be five feet longer, and the length of it will be much greater in proportion to the principals."

"I see that the girder must be terribly weak," said Lucy, "and likely to bend in the middle."

"Yes," said Harry, "especially when the weight of the kitchen ceiling is to be added to it below. Then the question I ask you is, how would you prevent this girder from bending?"

"Could not you tie it up in the middle by a rope, fixed round the beam, and then fastened well to the top of the roof where the rafters meet?" asked Lucy.

"Very well," said Harry, "but why with a rope? If you please we will tie the girder in a man's way, with a piece of timber. A strong straight piece, called a *king-post*, is set up perpendicularly, and fastened into the middle of the girder at bottom, by *morticing* or *dove-tailing* it; and near the top, notches are cut, in which the upper ends of the principals are fixed; so that in fact this post hangs upon the

principals, and as they lean against it, they mutually support one another, and hold up the girder, which you see cannot bend in the middle now."

"That is excellent," said Lucy. "Now I understand it all."

"All as far as I have told you," said Harry; "but all is not perfectly safe yet. There is another thing which might happen, another danger of which I have not told you: in my roof, you see, not only the girder is much longer, but the sloping rafters also are much longer than in the old roof, and consequently weaker; they will require some further strengthening, especially if Sir Rupert slates the house, as he talks of doing, some time or other; my roof therefore must be able to support the weight of slates. How shall I strengthen the principals, and where? tell me before I show you my drawing."

"You should strengthen them in the middle of their length, I think," said Lucy, "where they are the weakest."

“ I think so too,” said Harry ; “ and how ? ”

“ Could not you put up sloping pieces from the bottom of the king-post, to the middle of the principals ? Would not this do, Harry ? ”

“ I hope so,” said Harry, “ for that is exactly the way I mean to do it. Here is my drawing now ; here are those sloping pieces, as you call them : their right names are, I believe, *braces*, or *strutts*.”

“ Two names ! ” cried Lucy ; “ I wish they had only one, and then I should have but one to remember.”

“ I am sorry they have two, but I cannot help it,” said Harry. “ A workman must know all the names, because they are sometimes called by one and sometimes by another, by different people.”

“ But one will do for me,” said Lucy ; “ for all I want is to understand you ; and if we agree upon one, and if you use that same word always, that will do.”

“ Then let us call them *strutts*,” said

Harry. "There are some of the parts of a roof which tend to *push* asunder sideways, and some which *pull* downwards. Now look at this triangle before our eyes; look at all its parts, principal rafters, girder, king-post, struts; tell me which tend to push and which to pull asunder?"

Lucy looked and considered each, and then answered, "These sloping rafters tend to push asunder, if they are not prevented by the girder."

"You need not repeat what prevents it," said Harry, "I am sure you know *that*. But now tell me plainly which have a tendency to push and which to pull."

"The principal rafters have a tendency to push out," said Lucy; the girder to pull them together; the king-post tends to pull downwards, especially if the weight of the ceiling of the room below is added to the weight of the girder."

"Right," said Harry. "It is necessary for any body who is to make a roof to know this clearly; because, when they come to the choice of their materials, they must

have pieces of different sorts to resist the *push* or the *pull*. But I need not explain this more to you, because you are not to be a workman. And now I think I have but little more to explain to you in my plan. I have three of these frames, connected in the same manner as in the old roof, by a ridge pole at top, and by the wall plates below."

"Three! only three of those frames," said Lucy. "Why should you have only three? In Dame Peyton's old roof you told me there were five or six, and yours is to be much larger."

"True, but I will show you how mine is to be strengthened. I am to have *purlins*, or, as some people pronounce them, *purloins*."

"And what are purlins, or purloins," said Lucy, "and where do they go?"

"They rest upon the principal rafters, just above *your* struts, which are put in on purpose to support their weight. A purlin is a long piece of timber, that goes horizontally across the frames, one on each side

of the roof; and as Sir Rupert talks of slating Dame Peyton's house some time or other, though it is only to be thatched now, my roof had better have purlins, to make it strong enough for slates. Smaller rafters are then placed between the principal-rafters; they are about a foot asunder, and are prevented, by the purlins, from bending. To these rafters the laths are nailed, at proper distances, according to the size of the slates or tiles which are hung to them. And now, as that is all I have to say, I will go and show my plan to my father. I hope," added he, stopping to consider, "that my roof is strong enough: if it is not, I must put in queen-posts, as well as a king-post; but perhaps that would make it too complicated. I think it will do without it. I will ask my father's advice."

"But first," said Lucy, "just stop one moment more, my dear Harry. What is a *queen-post*?"

"The queen-posts," said Harry, "are hung to the upper ends of the two struts;



and like the king-post, which supports the middle of the whole girder, they support the middle of each half of the girder. In roofs of great *span*, or width, such as of churches and playhouses, the queen-post has her struts also, forming fresh triangles just in the same way, and all for the same purpose, to prevent either girder or principal from bending; in short there is but little difference between the king and the queen."

"Except," said Lucy, "that she is neither so tall nor so strong. But thank you, Harry, for stopping to tell me all that. I understand it quite well."

"Then I am quite satisfied," said Harry; "and now I will go and show my drawing to my father."

"Why should not I go with you?" said Lucy: "I want to hear what papa says to your plan, and whether he likes it better than the woodman's."

"Come then," said Harry, "and you will hear all about it."

"It looks well, Harry," said his father, as he looked at Harry's drawing of his roof. "But now explain it to me."

"Will you let Lucy explain it, Sir?" said Harry, "I believe she can."

"Do so, Lucy," said her father.

She did explain it very well; and the uses of the several parts, and called each by its right name.

Her father smiled at the readiness with which she spoke of principal-rafters, girder or tie-beam, king-post, and strutts.

"I am not sure," said he, turning to Harry, "that knowing all these names may ever be of much use to Lucy; that must depend upon circumstances; but of one thing, which is independent of circumstances, I am sure, that the disposition your sister shows to turn her attention quickly to whatever interests her friends, and to learn all that can enable her to sympathise with them, even when she can no otherwise join or assist in their occupations, will make her, if she pursue this habit in her future life, agreeable as a companion, be-

loved as a friend, and amiable as a woman. But to return to your plan, Harry," added his father.

"Is a queen-post necessary?" said Harry.

"Not at all, Harry; your roof will be quite strong enough, if the timber is well chosen. I approve of your plan; and I am so well pleased with it, and with your wish to be of use, that I will give you all the assistance I can. I will, in the first place, look at the timber for you, and see that each piece is fit for the purpose, because you have not had experience enough to judge what will bear the weight or strain which is to come upon it."

"Thank you, father, that is the very thing I meant to ask; as I cannot do it for myself, I know, not only for want of experience, but of something else, father," added Harry, smiling; "something which I know I do want, and without which I cannot calculate for myself what weight or strain any roof or arch either would bear."

"Oh, mathematics you mean," said

Lucy. "No, papa would not put you in mind of that again, because he knows you are doing all you can. He has never missed his half hour at mathematics one single day, papa, even in the midst of this *great press of business* about the roof."

"I know it," said her father, "therefore I would not spur the willing horse; that would be cruelty, according to the best definition I ever heard of cruelty, the giving *unnecessary* pain.

After the timber had been selected, many little provoking difficulties occurred, such as to the young architect appeared extraordinary, but which his experienced father assured him were ordinary, and almost in evitable disappointments in carrying on any work. First the sawyer was not to be had the day he was wanted, to saw out the principal rafters; then the carpenter made a mistake in the height of the king-post; he cut it too short, and it did not fit. He said that Harry had given him wrong measures; Harry was forced to submit to this charge, though he knew it was unjust.

But he had not written down his measures, therefore he could not prove that he had been accurate in his directions. At length, however, the new-king post was made, and the work went on smoothly. Lucy watched its progress with great pleasure. She was interested in every part, not only as being Harry's *job*, but because she understood what was going on, and the use of each thing that was done. Even to the making of a *mortice*, and a *bird's mouth*, she learned exactly; for as she now knew the importance of making *joinings* and *fastenings* strong, she was anxious to learn how this was to be done, instead of being contented with the vague idea, expressed under the general words, things must be fastened or made fast.

At last the mason's and the carpenter's work were finished. The walls of the shed were raised; the wall-plates put on, and the roof on the wall-plates. The thatcher's work was brought to a close. The whole was complete. Harry, who had been unremitting in his attention to the business as

it proceeded, saw its completion with great satisfaction; and Lucy, ever his ready messenger of good news, ran, the harbinger of joy, to call her father. He came, saw, and approved; his approbation increased after a strict examination of every part of the construction and execution of the work. Lucy was delighted; and it would be hard to say which enjoyed most pleasure, she, Harry, or Dame Peyton. When the dame at length saw the place cleared of the workmen's tools, even to the last dab of mortar, and the last chip; when all before the door was swept as clean as besom and new besom could sweep, then and not till then she allowed herself to rejoice; then she put on her white apron, and came out to where Harry and his father were standing looking at the roof, and delight and gratitude were expressed in every line of her happy old face. She said, and she proved, that she could not be tired of looking at it. She went up into the loft, and examined it herself, and listened to all Harry's father said, and enjoyed every

word and look of commendation bestowed upon Harry and upon the roof, but was very discreet in not offering a word of praise herself of what she knew nothing about.

Only this she knew right well, that she was very much obliged to Master Harry, and that she should feel the comfort of his roof as long as she lived, she was sure.

Sir Rupert Digby also came, saw, and approved, after an equally careful examination. He thanked Harry for the pains he had taken ; observed that he had not over-rated his powers ; and said, that, independently of the service done to Dame Peyton and to himself, he was heartily glad to find, that Harry could steadily go through with such an undertaking as this. It must give him confidence in himself for the future.

Sir Rupert's commendation was given, not lavishly, but in a very careful, measured manner ; it was plain that he would have liked to say more, but that he refrained. The more he liked any young persons, the more careful he was, not only to avoid flattering, but even to abstain from giving

them the high wages of praise early in life, however well earned.

“There is so much,” said he, “of hard work which must be done in after life, and gone through without praise by all who do their duty, that we ought not to overpay in the beginning.”

“For fainting age what cordial drop remains,  
If our intemperate youth the vessel drains.”

Whether all his young friends approved of this anti-praise principle of Sir Rupert's, or whether, like Harry, they liked him all the better for it, we cannot decide. Lucy looked doubtful; but one point is certain, that she much liked the next thing he said, which was, that Lady Digby and he hoped that they would all come the next Monday morning to pay them a long-promised visit at Digby Castle. It must be, he added, a long visit; he had much to show his young friends; and he hoped to be able to amuse and make them happy, though he could not promise them any companions of their own age, as none of his nephews or nieces



were to be had ; and his son Edward, his only son, was at Cambridge. But there was a workshop at Digby Castle, and that he knew would be enough for Harry ; and an old garden and an old hermitage for Lucy, to say nothing of a new conservatory ; and a library for all, with books that were not locked up ; chess boards ; battledores and shuttlecocks ; nine pins in the great hall, for rainy days ; and bows and arrows, and a target on the green, for fine weather.

If such delights the mind may move,  
who would not wish to go to Digby Castle ?

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HARRY and Lucy's father and mother had now been at Rupert Cottage for several months ; and on some happy Monday, late in spring, we find them actually on the road to Digby Castle.

" Which way would you please to go, Sir ? " said the postilion, looking back ;  
" would you please that I should drive round by the new approach, as they call

it, or turn up here, by the avenue; this is the nearest way, only it is up hill, Sir?"

- "Go by the avenue, if you please."

Harry and Lucy were glad of that. They drove in through a massive gateway, under the spreading arms and meeting branches of fine ancient oaks.

"Now for the first sight of the castle," cried Lucy; "and there it is, look Harry, with its towers and turrets, and spires, and pointed pinnacles. It is a Gothic castle, I know; I have seen a print like it in Britton's Beauties of England. Look out at my window, Harry, and you will see much better."

While they slowly ascended the hill, they had leisure to examine the front of the castle, though it was now and then intercepted from their view by the long-extending arms of the trees."

"I like that great deep dark archway entrance between those two projecting towers," said Lucy.

"So do I" said Harry.

"I like it because of the light and shade," said Lucy, "and because it is like a pic-

ture; it is picturesque, is it not, mamma? It is very pretty."

"I like it, because it is very useful too," said Harry. "It looks solid, and secure; no danger of that arch ever giving way, even with all the weight of that pile of building on the top of it. Before it could come down, the arch must thrust out those two solid round towers on each side against which it butts."

"True, Harry," said his father, "that is the use of those weighty towers, which you will often see in the arched entrances of Gothic buildings."

"I like those spiry pinnacles," said Lucy.

"Yes, the *minarets*, as they are called, are very pretty," said her mother.

"Mamma, I like those pointed arches better than round arches," said Lucy; "and I like those hanging-out bow windows too, those which look like three windows bound in one, with carved stone-work frames, and with all those ornaments of scollops and roses over each window."

Her father told her that what she called the stone-work frames, which divide the

light into compartments, are called *mullions*. He told Harry it was as well to know the right names of these things, especially as they can be learned with so little trouble at the time we see the buildings before us.

"I like the lattice windows," said Lucy.

"Outside they look pretty," said Harry; "but I should think the rooms must be very dark within."

He observed 'slits instead of windows in one old tower, and he supposed that these were used for shooting through, in the time of bows and arrows.

"I like the little jutting-out windows, mamma," said Lucy.

"They are called *oriel* windows," said her mother.

"Oh yes, oriel windows. I hope we shall sleep in one of those rooms. We are to stay some time, you know, Harry."

"I am glad of it," said Harry, "that we may have time to look at every thing. I hope we shall go all over this castle. It looks very large."

"Yes, and for only two old people to

live in," said Lucy; "Sir Rupert and Lady Digby; I should think that they would be quite melancholy in it, and almost lose their way."

Her mother told her that they had often friends in the house with them, and that part only of the castle was inhabited at present; the other part was unfurnished, and she believed shut up.

Lucy particularly hoped that they should see this part; and she also hoped that there was a dungeon, and a keep, and a moat, and a draw-bridge; of all which things she had read in descriptions of old castles.

Her father told her, that there had been a drawbridge over a moat which had surrounded this castle, but the moat had been filled up, and the draw-bridge destroyed.

Harry regretted the draw-bridge; he should have liked to have seen how it was pulled up and let down. Lucy moaned over the loss of the moat; but, upon being cross-questioned, it appeared that she had no clear idea of what a moat was. Her father told her that it was only a deep wide

trench, or ditch, over which the draw-bridge was let down, to admit those who were to be received at the castle, and drawn up again to prevent the entrance of enemies; and that during the old times of the civil wars almost every castle had its draw-bridge, and its moat, which was sometimes filled with water and sometimes dry.

The idea of the moat being only a deep ditch satisfied Lucy for its having been filled up; and her father told Harry, that he might see the traces of where it had been when they walked out. As to the *keep* for which Lucy inquired, her father told her, that the keep of a castle means the strongest part of the building, to which the inhabitants of the castle used to retire when the besiegers had taken the out-works. The *dungeon* was usually at the bottom of the keep; but there was no chance of her seeing one here, as it had been long since destroyed. Harry rejoiced that both the days of civil wars, and of baron's tyranny, were past; and Lucy

said she would be content without going into a dungeon.

By this time they had driven over the filled-up moat, and reached the entrance to the castle. Harry's father showed him, at the top of the archway, the remains of the *portcullis*; a sort of gate, which was framed of thick cross bars of wood, and made so as to let down in case of surprise, to defend the entrance. A good old peaceable porter now stood where the portcullis had formerly been let down.

They entered the castle by a spacious hall; at the farther part of which was a dark oak staircase, in two flights of low steps, leading to a gallery across the end. In this hall there was a vast fire-place, a huge oak table, and a set of black chairs curiously carved. A pair of jack boots, and a cross-bow, hung on one side of the fire-place; and on the other a stag's head, with branching horns. Along the wall, opposite to the fire-place, hung a row of small black buckets. Harry was

going to ask what was the use of these, but Sir Rupert Digby at that moment came into the hall, to welcome them. He told them, that a large party had left the castle that morning, and that they had the house to themselves.

"We shall dine early; so that the young people may have time to run about, and divert themselves as they like," added he, looking at Harry and Lucy. He saw Harry's eye glance at the buckets. "Guess what is the use of those?" said he. "I should tell you, that they are not made of wood, but of leather."

Harry guessed rightly, that they were to carry water in case of the castle being on fire. Lucy thought there was little danger that this castle should be burned, the walls looked so thick: she forgot the roof. In the room in which they dined, she observed the great thickness of the walls, which admitted of three chairs, standing beside each other, in the recessed windows.

After dinner was over, including the best part of dinner, in the opinion of young



people—the dessert—Harry and Lucy were told, by kind Sir Rupert, that they might go, if they pleased, and amuse themselves by looking at the castle; perhaps they could find their way over it alone, and would like better to do that than to have any body to show it to them. Lady Digby promised to have them summoned whenever they should go out to walk. “But we old people like to sit some time quietly after dinner, and you young folks like to slip down from your chairs directly, and run off.”

“So off with you,” said Sir Rupert, “and be happy your own way. Only remember,” added he, “there is one door which you must not open till I am with you: the first door on your right hand, as you leave the hall to cross the court.”

“Describe it to us very exactly, if you please, Sir,” said Harry, “lest we should mistake.”

“You cannot mistake it,” for it is of iron,” said Sir Rupert, “and all the other doors are of wood.”

"Of iron!" repeated Lucy, as soon as she and Harry were alone together in the hall; "an iron door! not to be opened. I remember when I was at Aunt Pierre-point's I heard them reading some story of mysterious doors. I wonder, Harry, where that iron door leads to."

"My dear, why should it be mysterious because it is made of iron?" said Harry.

"No, not merely because it is made of iron, to be sure," said Lucy, laughing, "but because it is never to be opened."

"Till Sir Rupert is with us," said Harry. "I suppose there is something that would be dangerous for us to meddle with in the room."

"What sort of thing, Harry, do you think it is?"

"I do not know, and I do not care," said Harry. "I dare say it is nothing that would divert us; at all events we may be contented with looking over the rest of the house. Sir Rupert would have told us, if he had chosen that we should know

more; and I advise you, my dear Lucy, not to think any more about it."

"Very well; if it is not right I will not," said Lucy; "only I am a little curious."

"Very likely. Very natural for women; but conquer your curiosity," said Harry. "Come, run up this flight of stairs, and I will run up the other, and meet you in the middle of the gallery. Who will be up first? one, two, three, and away."

They ran up, and their heads met in the middle of the gallery, with such force, that the light flashed from their eyes; and, as Lucy said, all curiosity was driven out at once. Recovering after her forehead had been well pitied, and after Harry had comforted her by the assurance that it was red, and would grow black, and that she had been certainly very much hurt, she looked to see where they were, and where they should go next. They saw a large lobby, into which the gallery opened, with many doors on each side, and a *mullioned* window at the end. Harry ran and opened the doors on

one side, and Lucy on the other. Lucy's doors opened into bed or dressing-rooms, like any other rooms, only that the furniture was more massive and old-fashioned than usual, with plenty of japanned cabinets, and high folding skreens. It was all very comfortable, but nothing new or extraordinary. She ran back to see what Harry had found, whom she heard calling to her to follow him. She followed through innumerable little dens of rooms, all unfurnished ; some hung with tapestry, some wainscotted, some bare walls, all with corner chimnies, and deeply-recessed lattice windows.

"What pigeon holes of rooms," cried Lucy. "Little light, and great height; there is scarcely room for a bed, and a chair, and a table, and no room for a sofa."

"Sofa indeed, nobody thought of sofas, or such luxuries, in those war times," said Harry.

"Fine comfort people had in their fine castles in olden times, as they call them," said Lucy. "Bed chambers in-

deed! There is scarcely room even for such little people as you or I, Harry, to turn about. How could great people manage? especially when they wore hoops, which I believe they did in those days."

"Not men," said laconic Harry.

"Not men," said Lucy; "but they wore armour, and swords, or daggers, which must have taken up room. There is more space in my little room in our cottage."

The space that was wanting in the rooms, Harry observed, was wasted in the walls, and in the passages. As they were crossing one of these, they opened a little door, through which they looked down into a narrow empty space, cut out in the thickness of the walls.

"What could be the use of these places," said Harry; "with all these spiral staircases, and odd niches?"

"These were for hiding places in the wars, perhaps," said Lucy.

"As if men and warriors would hide like cowards," said Harry.

“ But women and children would be very glad to hide,” said Lucy ; “ and plate, and goods, must be hidden : and I have heard even of men, and warriors too, who were very glad to hide, and to be hidden ; but now those vile civil wars are over, these places and these rooms seem to be good for nothing but to play hide and seek in.”

Lucy went forward, and opening a folding door, exclaimed, “ Here’s a room large enough to please us, Harry !”

“ It could contain half a dozen of the others,” said Harry.

“ I suppose this must have been the state bedchamber,” said Lucy, looking at the remains of a crimson velvet bed, whose heavy canopy, within a few feet of the ceiling, was supported by a rough cord, hung to a staple.

“ I wonder,” said Lucy, as she looked at the remnants of a laced counterpane, which covered the low bed, “ whether any king or queen ever slept in this uncomfortable bed ; and I wonder whether there were

any mysteries belonging to the people who lived in this place."

"Mysteries," repeated Harry, "always at mysteries! I do not know what you can mean."

At this instant something between a sigh and a groan was heard from an inner room."

Lucy grew pale.

"A dog, I suppose," said Harry.

They listened again, and next was heard a thundering noise, as if the house was coming down.

"Stand still, my dear Lucy," said Harry, catching hold of her. "No danger here," said he, looking up to the ceiling, which he saw was safe. "I suppose that some part of the ceiling has fallen in the next room; stand you still and safe, and I will go and peep."

He went forward, and looking through the key hole, began to laugh, and bid Lucy come on and see what was to be seen.

He pushed the door open, and Lucy,

recovering the use of her knees, joined him. They saw a boy standing beside a heap of small billets of fire-wood, which he had just emptied from a basket; and while replacing it on his head, he was grinning at the glorious noise he had made.

The boy had his back towards them; and when he turned and saw them, he started with a face of stupid surprise.

"These be the annulled rooms," said he.

"The what rooms?" said Harry.

"These be not the habited rooms," said the boy; "you have missed your way, I take it: but you may get down this way into the court, and so into the hall, if you go down this back stone staircase; but mind the steps as you go, miss, if you please, for they be a little *ticklesome*."

But Lucy, instead of attending to the boy's caution, only laughed at the word *ticklesome*; and as she followed Harry down the stairs, she began telling him about something she had heard, or read, when she was at her aunt Pierrepont's,



from the book of mysteries, which had frightened her at the time, and had left an impression of foolish terrors upon her mind. While she was talking very fast, her foot slipped, and down she fell; and would have fallen to the bottom of the steep stairs, but that Harry, who was a few steps beneath her, stopped her fall, and saved himself from being thrown down, by setting his foot against the wall at the turn of the staircase, for there were no banisters to catch by—and thus propping himself, he sustained her weight, till she scrambled up and regained her footing, lugging his hair most unmercifully.

“Now, my dear Lucy, pray have done with your mysteries, and mind where you put your feet,” said Harry.

“I will,” said Lucy, much humbled, and trembling all over.

“Did you hurt yourself much?” said Harry.

“I do not know, but I believe I am a little scratched,” she answered.

"I am sure my hair was not a little pulled."

"My dear, I really beg your pardon; but I was so frightened, that I did not know what I did."

"You had cause to be frightened *then*. But now you are quite safe, sit down on this step, and rest till your colour comes back again," said Harry, looking at her, as the light, through the slit in a loop-hole of the wall, shone upon her face.

"Harry, I hope I did not hurt you very much?"

"Oh! no, my dear: what man minds a pull of his hair for a sister?"

"You are very good," said Lucy.

"Then do you be very good; and do not say one word more till we are at the bottom of these *ticklesome* stairs."

They reached the bottom in silence, and safety, and found themselves in an open court-yard.

"With the iron door on our right hand," said Lucy. "Look, Harry, there it is."

"Yes, miss," said the housekeeper, who was crossing the yard, "that door leads only—"

"Stop, if you please, ma'am," cried Harry: "do not tell us any thing about it, for perhaps Sir Rupert Digby does not wish us to know where it leads to. He bid us not open it."

"There is an honourable young gentleman," said the housekeeper. "So I shall say no more."

The housekeeper passed on about her own affairs, with her great bunch of keys in her hand, and Lucy followed Harry across the court.

"I am sure, Harry," said she, "there is nothing wonderful about that door, because she said that door leads *only*—that word *only* has quite killed my curiosity."

"I am glad any thing could kill it," said Harry, laughing.

He turned to a part of the house which they had not yet seen; but Lucy ran up some steps to look at an old-fashioned garden,

which she saw upon the slope of the hill, at the back of the house. Harry followed her. The garden was cut in terraces, one above the other, with sloping banks, and steps leading up to them cut in the turf, and high horn-beam hedges, instead of walls, surrounding the garden. They ran on through long alleys, between double rows of thick yew hedges. Harry said these were as good as walls, and better, he thought, because nobody could get through or over them, so easily as over a wall; and they looked green, and pretty, in winter time.

Lucy said she would have them in her garden, when she grew up, and had a garden of her own; but she would never have any of her yew trees cut into strange forms of globes, and pyramids, and wigs, such as those she saw here. An old gardener, who was clipping one of the hedges, told her he advised against them; "for I have been making war," he said, "with the slugs and snails, black and

white, these sixty years and upwards, and I could never rid the earth of them, on account of these receptacles for vermin, these yew hedges."

"Good and bad in every thing," said Harry; "one cannot see it all at first."

Lucy was struck with the gardener's ancient appearance, and said he looked like the picture of a hermit.

At the word *hermit* he turned again; and told her, that if she had any fancy to see a hermit, she might go on through the labyrinth, till she should come to the hermitage, where she would find an old man, a great deal older than himself—it might be two or three hundred years old—for he was of wood, and indeed a little worm-eaten.

Lucy ran through the zig-zags of the labyrinth, and reached the hermitage, where they found the two hundred years old hermit, looking very yellow, leaning with one mouldering hand upon his table, inlaid with shells, the other hand holding

a wooden tablet, on which was an inscription that Harry tried to decipher; but it was so worm-eaten, that many of the letters were gone; and when he touched the tablet, the wood in some places crumbled to dust, eaten, as it had been, by the little insects, which, with their tiny forceps, bore their way through the hardest wood.

Harry could decipher only two words of the worm-eaten inscription; these were, "rightly spell."

"Oh!" cried Lucy, "I know it all from those two words."

"How can that be, Lucy," said Harry; "for here are one, two, three—six lines in this inscription; and how can two words tell you all that?"

"You shall hear," said Lucy. She repeated the well-known lines from Milton's *Penseroso*; which have probably been inscribed, a million of times, in different hermitages in England.

"And may at last my weary age  
Find out the peaceful hermitage ;

The hairy gown, and mossy cell,  
Where I may sit and *rightly spell*  
Of every star that heaven doth shew,  
And every herb that sips the dew."

Harry acknowledged that she had rightly spelled and put it together. "How curious," said he, "that only two words brought the whole to your mind."

"Very," said Lucy. "But now look at this curious shell-table."

She had, however, scarcely time to examine the colours and shells of its radiated compartments; nor had Harry leisure to decipher an inscription in old English letters, in the scroll the hermit held in his other hand, when they heard themselves called. The seventy years old gardener came after them, to say, that Sir Rupert Digby was calling for them, and that the company were going out to walk in the park. He guided them out of the labyrinth, by a short cut across the zig-zag paths, and showed them down some steps which led into the park, where their father

and mother, and Sir Rupert and Lady Digby, were waiting.

They now took a pleasant walk through the grounds, and went to see a beautiful Gothic church, adjoining the park. Sir Rupert had some thoughts of repairing the roof, and consulted Harry's father about the best manner of doing it. Harry listened, and heard much about pointed architecture, and flying buttresses: and at last he learned by listening, and looking, what was meant by a flying buttress. He found, that a buttress meant a prop of stone-work, or bricks, built against the outside of any wall, to support it; and a flying-buttress he saw was a prop of mason-work, raised in the air, like part of an arch, as it were, and flying over from one portion of a building to another, in order to support a weak and light part, by butting against some other which was strong and weighty.

Lucy observed, that the word Gothic sounded as if it came from the Goths; and she asked whether Gothic churches, and



Gothic arches, were built by the Goths, or came from their fashions of building ?

Sir Rupert Digby turned to Lucy on hearing this question, and answered, "That is a very natural and plain question, my dear ; but, plain as it is, I am afraid we can none of us give you a plain answer. It is a question, which has led to endless disputes, among the learned and the unlearned. Some have used the word Gothic, applied to architecture, as a term of reproach ; meaning barbarous, clumsy building, such as might have been built and invented by barbarians, like the Goths : others, who admire these pointed arches, and all that is commonly called Gothic architecture, will not allow that it originated with them. They maintain, that it is too beautiful, and too good, to have been the invention of men who had neither taste nor science."

"But what do they call it then, sir?" said Harry, "and from whom, or from whence do they think it came?"

"More plain questions, to which I

cannot give plain answers," said Sir Rupert. "Half a dozen contradictory answers may be given to your questions—where did it come from? and who brought it? Some say that the pointed arch came from the north, some from the south, and some from the east: some, as I told you, are sure it came with the northern Goths; others say it came from Egypt: some are clear that it came from the eastern Saracens—some from the western Moors—some from Normandy—and some from Jerusalem, brought into England by those who returned from the crusades; and one fanciful gentleman maintains, that pointed Gothic arches were suggested by the curves formed by the meeting branches of certain trees; and he has, I believe, planted an osier-aisle, like that of a Gothic cathedral, to prove his theory."

"Very ingenious," said Harry: "but after all, what is the truth, do you know, sir?"

"I cannot pretend to decide where so

many judges disagree," said Sir Rupert ;  
" but perhaps it will be most useful to you,  
my dear, only to tell you a few facts, which  
are established and admitted by all."

" Thank you, sir," said Harry and Lucy.  
" That is just what I like," added Lucy ;  
" for I hate, when a thing has been put  
into my head, as I think quite right, to  
find it quite wrong some time afterward—  
all to be taken out again."

" That is, however, what must con-  
tinually happen to us all, my dear, in the  
imperfect state of our knowledge," said her  
father.

" It has happened to me upon this very  
subject," said Sir Rupert, " more than  
once. But to tell you, in short, the little  
I know. This round semicircular arch,  
which you see here, and these heavy round  
columns, such as you have seen in many  
cathedrals, are much more ancient than  
the pointed arches, and the lighter pillars,  
and the mullioned windows, with all their  
*tracery* work, which you admire, Lucy.

The semicircular arch, with its heavy round columns, is supposed to be of Roman origin, and to have been brought by the Romans into Britain, and adopted by our Saxon ancestors ; thence it is called the Saxon arch. The pointed arch, and all these little spires and rich ornaments, are of much later date ; that point is fixed, though I cannot pretend to tell you exactly how much later."

" But who invented them ? could you tell me that, sir ?" said Harry.

" No, that would be too dangerous a point for me to settle," said Sir Rupert. " You may read some time or other all that has been written on the subject, and judge for yourself. In the mean time, the safest way is, simply to call that style of architecture in which the pointed arch is used, the *pointed style*, a term that cannot well be disputed."

" By any who have eyes," said Harry.

Leaving the partisans of the Saracens, and the Goths, and the Moors, and the

pyramids, and the osiers to fight it out, and settle it their own way, Lucy went to look at the rich tracery, and other ornaments, in part of this church, which her mother and Lady Digby were admiring. The ceiling was beautiful. Meeting arches, with fan-like ornaments, as Lucy called them, and pendent drops, hanging from the points where the arches met. Sir Rupert told her, that this kind of highly-ornamented Gothic architecture was in its greatest perfection in England, about the time of Henry the Seventh; and that the finest specimen of it is to be seen at Cambridge, in King's College chapel.

Harry and Lucy's father promised, that he would take them to see it if ever they should go to Cambridge.

"And now," said Sir Rupert, "we had best think of going home to tea, for I see through this coloured glass the light of the setting sun. I am afraid I have given you too long a lecture on Gothic architecture; but when once set a going on that favourite

subject, I do not know how to stop. To make you amends, I will take you home by a new and pretty walk."

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IN returning to the castle, they passed through a wild part of the deer-park, where there was a profusion of fine primroses. Harry amused himself by sticking some of them into the ribbon round the crown of Lucy's straw hat.

As they walked on, and came near to the place where the spotted deer were browsing, the deer looked up, and stood gazing upon them, with their large dark protuberant glassy eyes, necks erect, and branching antlers thrown backwards. After an instant standing at gaze, the foremost of the herd turned short about, and made off, and all the others followed him at full trot. Lucy was sorry for this, and fancied that they had been frightened by her chaplet of primroses, which she now took from

her hat: but Lady Digby assured her, that the chaplet was not to blame; that deer are such timid creatures, that they are startled by the least noise, and never suffer any strangers to approach them; but, like almost all other animals, they can be tamed by kind treatment. Sir Rupert told Lucy, that he had seen a tame deer belonging to a regiment so docile, that he would let a little boy ride upon him; and even permit the soldiers to amuse themselves by sticking their knapsacks upon his antlers.

Harry and Lucy, who ran on before the rest of the party, presently came to a sort of fence, which divided the park; it was made of a single cord, stretched between posts, with feathers stuck across the cord at intervals. Harry and Lucy waited till Sir Rupert came up, and then asked what this was for. Sir Rupert told them, that it was an experiment of his gamekeeper's, who had assured him that this sort of fence was the best that could

be used to prevent deer from straying beyond any prescribed boundary. They are frightened by the fluttering of the feathers, and never attempt to leap or pass this fence. "This may be true, or it may be false," said Sir Rupert, "experiment must determine. I never allow myself to decide, without trial, against what are called vulgar errors."

Nothing further, worthy of note or comment, happened during this walk.

They drank tea in a part of the castle which Harry and Lucy had not yet seen; in a long gallery, which, as Sir Rupert told them, had been much longer, magnificently, but uncomfortably long, so that it could not easily be warmed by day, or lighted by night; therefore he had taken off a room for himself at one end, and at the other end had made a conservatory for Lady Digby. The middle part was now fitted up with bookcases, and was not too long to be easily and well warmed in winter. Over the chimney-piece there was a



picture of a man in armour ; whose countenance, as Harry observed, was more thoughtful than warlike, more like a philosopher than a soldier.

After tea, Harry returned to the picture, and asked if it was a portrait, and of whom ? Lady Digby told him that it was a portrait of an ingenious and learned man, who was connected with their ancestors, and from veneration for whom the name of Rupert was given to Sir Rupert Digby. This was the portrait of Prince Rupert.

“ Prince Rupert ! ” exclaimed Harry, in a tone of delight and admiration.

“ Prince Rupert ! ” cried Lucy. “ Oh ! let me look at him, if he is your Prince Rupert, Harry, who discovered the wonderful drops.”

“ He is,” said Lady Digby ; “ did you ever see those drops ? ”

“ Never,” said Lucy ; “ I have only heard of them from Harry ; he described them to me ; he told me, that if I had one

of them in my hand, and were to hold it fast, while he were to break a bit off the slender glass neck, the drop would directly explode, with a loud snap; and he said that I should feel an odd sort of tingling in my hand, and find that the glass had broken into thousands of pieces. Prince Rupert," continued Lucy, looking up at the picture, "I am glad to see you, and I should like very much to see and hear one of your wonderful drops."

Sir Rupert Digby told her that he believed he had some in his laboratory; and that, if he could find them next morning, he would show one to her; but it was now too late in the evening; he did not like to go into the laboratory by candle-light, as he had there various combustibles, of which it was necessary to be careful.

This evening he produced, for Harry's and Lucy's amusement, a portfolio of prints and drawings; among these he showed them an engraving of his illustrious namesake, Prince Rupert. Harry looked closely

at the print—so did Lucy ; then smiling, she said —

“ I know, Harry, what you are thinking of. It is — and it is quite just.”

“ It is,” replied Harry, nodding, “ and it is quite just.”

“ It is,” echoed Sir Rupert, “ and it is quite just. I know,” added he, “ what you are both thinking of.”

“ I have no doubt that whatever is, is right,” said Lady Digby ; “ but it is always a pleasure to have it illustrated ; therefore pray explain.”

“ And though I dare say you all understand each other,” said Harry’s father, “ let us make sure of it. Remember the two Dervises, in the Persian Tale, who held up their fingers, and made signs, and nodded, and pretended to understand one another, but were found out at last each to mean different things, or to mean nothing at all. Pray explain, Lucy.”

“ I was thinking,” said she, “ of what

Harry told me a great while ago, "that Prince Rupert invented this kind of engraving: I forget the name of it."

"Mezzotinto," said Harry."

"And," continued Lucy, "when I looked close at the print, and said, *it is*, and *it is quite just*, I meant that it was mezzotinto; and it was quite just that Prince Rupert's own portrait should be preserved in the sort of engraving which he invented."

"Exactly what I meant," said Harry.

"And what I thought you meant," said Sir Rupert.

"You were not like the cheating Der-vises, it is clear," said Lady Digby. "But now I wish that you, Harry, would describe to me how this sort of engraving is done,"

Harry took up a knife, which lay on the library table, at one end of which was a very fine file. He showed the lines upon the file, which were cut in two directions, obliquely crossing each other. "I be-

lieve," said he, " that the copper-plate on which a mezzotinto engraving is to be made, is, in the first place, cut all over into fine lines and furrows, like this file ; then, if the whole plate were inked over, with the ink used by engravers, and pressed off on paper, there would be only a dark engraving of crossing lines and dots, such as these which we see in this mezzotinto engraving. But when we want to have a design engraved, the outline is drawn upon the plate, after the lines have been cut. Wherever the lights are to be, the engraver scrapes away the ridges ; and for the strongest lights, where the paper is to be left white, he scrapes away quite to the bottom of the furrows ; and polishes the plate smooth, in that part. For all the lesser lights and shades he scrapes away in proportion, or leaves the ridges as deep and strong as they are wanted. The plate being then inked all over, and pressed down upon paper, and rolled off, the impression of the engraving is made, and in

lines and dots like this, or any other mezzotinto print."

Lady Digby thanked Harry, who had worked hard to get through this explanation; colouring redder and redder, as he went on, till it was happily completed. Sir Rupert wrote something at the bottom of the print of his namesake, and then gave it to Harry.

Lucy read with joy these words:—

"For a young friend, whose early admiration of excellence gives the best promise that in time he will himself excel."

Lady Digby found a sheet of silver paper, and a roller, on which she rolled the print; which, by the bye, some connoisseurs will say is the worst thing she could have done for the engraving. The most experienced assure us, however, that if you roll a print, or drawing, with the back towards the roller, all will be safe.

"Harry, before you go to something else," said Sir Rupert, "can you tell me by what accident, or by what observation,

Prince Rupert was led to the invention of mezzotinto engraving?"

"I could," said Harry; "but what use, sir, when you know it already—much better than I do."

Harry said this rather in a gruff tone, being seized at the moment with a twinge of his old complaint of bashfulness. When he had thought that Lady Digby really and truly, for her own sake, wanted to have the thing explained, he had exerted himself to get through the explanation; but now he thought just what he said, that it was of no use—except, perhaps, to *show him off*, which was what he detested. His father, however, put the matter in a new light to him, by saying,

"It may be of no use to Sir Rupert Digby that you should explain this to him, Harry; but it will be of use to yourself; for you have often found, that you are not sure of knowing any thing clearly till you have tried to explain it: and, above all, it is necessary for a man to be able to con-

quer the sort of reluctance to speak, when called upon, which you feel at this moment."

Harry made a desperate effort, and went on directly, not in the best words possible; but any were better than none; and he cleared up, and had more power of choice as he went on.

"I believe—I am not sure—I think, that one day Prince Rupert happened to see a soldier cleaning a rusty fusil, as they called it—that is, a gun—and I suppose, but I do not know exactly how it was—but I suppose Prince Rupert saw the impression of the rusty gun left upon some some piece of wood, or paper; and he observed, that where the rust had been scraped away most, or least, the impression was the strongest, or the most faint; and the Prince being an ingenious man, thought of applying this to engraving. He thought, that if the whole plate for any engraving were *roughed* over, as the gun was with rust, and then scraped away clean, more



or less, for the lights, in the way I before described, this might do ;—so he tried, and it succeeded. He was the first who ever made a mezzotinto engraving, with his own hand ; I remember that, for I thought how happy he must have been when it succeeded.”

“ Oh, I recollect,” cried Lucy, “ another interesting thing, Harry, which you told me, about the Prince having suspected his servant of stealing his tool, and finding he was mistaken ; and his generosity, you know, about giving him—I forget what—at last.”

Harry explained for Lucy, that an engraver, who lived at the same time, discovered, by his own ingenuity, the Prince’s method of engraving, which had been kept a great secret. This engraver made some mezzotinto engravings, and Prince Rupert happening to see one of them, suspected at first that his own servant had secretly taken away his tool for preparing the copper, and had shown, or lent it to the en-

graver: but the engraver convinced Prince Rupert that his suspicion was unjust, for he showed him the tool which he had used—it was a *file*; but the Prince's was a *roller*, with small grooves. When the Prince was quite convinced that there had been no unfair play, and that his servant had not betrayed him, he generously made him a present of his roller.

Some of the engravings in the portfolio were coloured. There was a set of prints of the odd and pretty dresses of the peasants belonging to different cantons of Switzerland. While Lucy amused herself by looking at their little straw hats, stuck on one side of the head, and their long plaited tails, and their horse-hair butterfly-wing caps, Harry was equally happy looking at some engravings, which Sir Rupert was showing his father, of Gothic cathedrals, and some views in Britton's *Architectural Beauties of England*. Every now and then Sir Rupert kindly turned to Harry, and stopped in what he was saying,

to tell him of the names and use of the different parts of the buildings; and to explain to him, gradually, a little more, and a little more, about the different styles of architecture which have prevailed in England at different periods.

Bed-time came too soon.

“As it always does,” said Lucy, “when we are busy and happy.”

Lady Digby put into her hand a little lamp, which was so pretty that it was enough to comfort any body of her age, for being obliged to go to bed. The little glow-worm flame burned bright, within a globe of glass so sheltered, that there was no danger of its being blown out; and the oil in its invisible receptacle was secured from dropping on clothes, carpet, or floor, even in the hands of the careless, who run, or of the sleepy, who slope their candlesticks as they walk. Whisking it over her head, and flourishing it as she went, Lucy proved the value of these properties; and Harry only wished that it was

a gas instead of an oil lamp. He hoped to see a portable gas lamp some time or other.

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AFTER breakfast, when letters and newspapers had been read and discussed, Sir Rupert recollected his promise to Harry and Lucy of showing them some of Prince Rupert's drops; and he saw, in their eyes, their eagerness for its accomplishment.

"Follow me, then," said he, "to the laboratory."

They followed him down stairs, through the hall, into the court, when, turning to the right-hand, he stopped at the iron-door.

"So it is only the door into the laboratory after all!" cried Lucy, as he opened it. "You were right, Harry, to advise me not to raise my expectations, or to fancy some grand mystery: how disappointed I should have been. Only the door into the laboratory! And why was it made of iron?"

and why, sir, did you bid us not open it?"

Sir Rupert told her, that this door was made before his time, when the room was used, perhaps, as a place of safety for papers, or money; and an iron door was the strongest for defence, and the best security in case of fire. He had desired Harry and Lucy not to open it, because he kept in this laboratory some things which might be dangerous, if incautiously meddled with.

As she entered the laboratory, Lucy was very cautious not to touch any thing, and looked with reverence round her.

Sir Rupert produced one of the drops which they came to see. It was a slender piece of solid greenish glass, about the thickness of a currant, but shaped somewhat like a pear, with a long delicate stalk. Giving it to Lucy, he bid her shut her hand over it, and hold it fast; he then broke off the end of the little glass stalk, and instantly Lucy heard a snapping noise, and felt a smart twinge, as she

described it. On opening her hand, which she did with a start, the instant she heard the crack, countless pieces of glass, fine as sand, fell to the ground: this was all that remained of the lump, which had thus shivered to bits. Lucy looked astonished at what had happened, and for a moment remained in silent wonder. Harry asked to have it explained.

“First I will tell you how these drops are made,” said his father; “by letting hot melted glass, such as you saw at the glass-house, fall into cold water.”

“I recollect, papa,” said Lucy, “that when we were at the glass-house, I saw a man dropping melted glass into a bucket of cold water; but I did not know what he was doing, and I little thought those were the wonderful Rupert’s drops. What else is done to them afterwards, papa?”

“Nothing, my dear. After they have been suddenly cooled, in this manner, by falling into cold water, each solid drop, or bulb, remains in the tadpole shape you see, each with his slender tail; and they

have the property, which you have just now seen, of bursting and shivering to pieces, with a slight explosion, when that tail is suddenly broken."

"*Suddenly* broken," repeated Sir Rupert, "as your father accurately says, Harry. The tail may be ground off gently, without bursting the drop. A friend of mine has tried this experiment\*," continued Sir Rupert. "He told me, that he had ground the bulb of one of these drops into the shape of a prism, without any explosion taking place."

"How curious," said Harry. "What can be the cause of this? Why does not the bulb explode when you grind off the neck slowly? and why does it fly into pieces when the neck is snapped off? Why does it explode at all, Sir Rupert? Will you explain the reason to us?"

"I am not sure that I *can*," said Sir Rupert; "but I will tell you what, from all the facts that are known at present, I

\* Dr. Brewster.

believe to be the cause ;—when a drop of melted glass falls into water, the outside of it, which first touches the water, is suddenly cooled, and becomes hardened and fixed before the inside parts have time to cool. You know, or you should know, that glass contracts as it cools. Now I suppose,” continued Sir Rupert, “ that the external crust of the drop cannot contract after it has been hardened ; and that, as the inner particles continue to adhere to it, so neither can they contract into their proper space. Being thus kept in an expanded state, they are forced to remain beyond their natural distance from each other ; and the thin hard crust has, I suppose, but just strength sufficient to retain them in this situation. Harry, do you understand so far ? ”

“ So far I think I do, sir,” said Harry.

“ Then, by snapping off the tail of the bulb,” continued Sir Rupert, “ the particles of the glass are supposed to be thrown into a state of vibration, which suddenly detaches them from the outer crust ; and,



by permitting them to yield to their natural attraction for each other, produces the explosion, which you heard. But if, instead of snapping the neck, we grind it away gently, no sudden vibration takes place, and the glass remains unshattered."

Sir Rupert paused—and the moment he did so, Lucy thanked him eagerly, and said she was very glad that she now understood *all about* these wonderful drops, and the reason of their exploding.

Harry, too, thanked Sir Rupert for his explanation, but his thanks were more sober; and he looked as if he was not quite satisfied, and wished to know more.

Sir Rupert smiled, and said, "I am glad to see that you, my young friend, do not swallow an explanation without chewing it. Perhaps I have not made what I mean clear to you."

"I think I understand what you mean, sir," said Harry; "that is not my difficulty."

"What then, Harry? Tell me your difficulty."

"I do not know how you are sure that this is the right explanation. That was what I was considering, sir." Harry answered with diffidence, yet without hesitation.

"I am not certain that I am right," Sir Rupert replied, with kindness in his voice and look. "You may recollect that I began by saying, that I was not sure I could explain this phenomenon satisfactorily, but that I would tell you what I *supposed* to be the cause of it."

"I remember that you did, sir," said Harry; "but I thought you meant, that you could not be sure of your explanation being intelligible *to me*."

"I meant more," said Sir Rupert; "that I was not, and cannot be certain of it myself, because it has not been proved by satisfactory experiments."

"I wish some good experiments were tried upon the subject, to bring it to a certainty, then," said Harry.

"So do I," said Sir Rupert; "and I am glad that you feel this desire to ascer-

tain the truth by experiment, the only certain way. But, Harry, this is a difficult subject; I advise you to put it by in your mind for future consideration. Remember clearly the facts, and do what you please with the suppositions. Some years hence, perhaps, it may return to your thoughts, when you may pursue it with more advantage than you can at present."

"Yes, when I have more knowledge," said Harry. "I will put it by in my mind, as you advise."

"But I hope you will not forget it," said Lucy, "as I do, when I put by things in my mind, and say I will think of them another time: I cannot find them afterwards."

"But this is likely to be recalled to your brother's memory," said her father, "when he learns chemistry, and studies the phenomena of crystallisation."

"Besides, I shall recollect it from all the pleasure I have had at Digby Castle," said Harry.

"This is one of the many differences

between cultivated and uncultivated young people," said Sir Rupert, addressing himself to their father, "that you *can* give them more pleasure than you can to ignorant children. Prince Rupert's drops could only have given the pleasure of one moment's surprise—a pop and a start—and a laugh, perhaps, and there would have been an end of the matter with most children."

As Sir Rupert spoke, his eyes chanced to turn upon Lucy, who blushed and looked very much abashed. When she was asked what was the matter, she said she was ashamed of having so hastily said that she understood all about these drops; she was afraid that Sir Rupert Digby had thought her conceited; and she imagined, that, when he looked at her as he spoke, this was what he was thinking of.

He comforted her with the assurance, that he did not think her conceited; but he perceived that she was a little too hasty in supposing that she understood the whole, when she saw only a part. Of many

grown up old logicians it has been justly said, that they see a little, imagine a great deal, and so jump to a conclusion. "Therefore," he added, "such a young reasoner as Lucy may be excused, and need not be so very much ashamed of herself; but she will do well to try to correct this propensity, and to imitate Harry's caution. "It is wonderful," continued Sir Rupert, turning to Harry's father, "that people should have been so long in discovering the simple truth, that all our knowledge of nature must be founded on experiment."

"What other method, then, did they take, sir?" said Lucy.

"They guessed, or reasoned, without trying experiments to prove whether they were right or not," said Sir Rupert. "They laid down general maxims, which they took for granted, because they had been found correct in a few instances."

"That must have been a bad way of going on, indeed," said Harry.

"Yes," said Sir Rupert; "when you come to read the history of the philoso-

phers of old times, and of the *alchymists*, and the *adepts*, as they called themselves, you will see, Harry, what strange work they made of it, and what absurd things they believed were the causes of what they saw in chemistry. Of this there are a thousand instances; but I do not, at this moment, recollect one to give you."

"I recollect one, I believe," said Harry, "which my father told me when we were at the barometer, that before people knew the reason why water rises in a pump, they used to say it was because *Nature abhors a void*."

"A good instance," said Sir Rupert; "and the best, or the worst of it was, that they were so well contented with this grand maxim, that they never thought of making further inquiry: they became, moreover, so obstinate in error, that they could scarcely see or believe the truth when it was shown to them. You know they were ready to burn Galileo, because he proved that the earth was round, and not flat; and that, instead of the sun moving round

the earth every twenty-four hours, it was the earth that turned round its own axis."

Harry felt gratified and obliged by Sir Rupert Digby's addressing so much of his conversation to him: but what pleased him most was the candour shown by Sir Rupert. Instead of being displeased when his own explanation had been questioned, he acknowledged that it was doubtful, and observed, that it ought to be brought to the test of experiment.

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THERE was a room at the east end of the library, which Harry and Lucy had not yet seen—Sir Rupert's workshop. He took them into it, and showed Harry his *turning-lathe*. He gave Lucy an ivory-box, which his son had turned when he was last at home. The lid was ornamented with a profusion of circles, lying like rings, crossing over each other; and within the rings were pointed leaves, one behind the other, each delicately cut, and finely embossed.

He showed Harry that simple and ingenious contrivance, the *eccentric-chuck*, by which these ornaments had been produced; and screwing it on the lathe, he not only explained the principle on which it acted, but the endless variety of devices that may be made, either by altering the distance of the centres, or by changing the place of the tool. There was a piece of ivory in the chuck; and when Sir Rupert put the lathe in motion, Harry was astonished at the quickness and accuracy with which these knots of circles were traced, and the ease with which the depth and breadth of each cut were regulated.

While Harry tried his hand and his foot at the lathe, Lucy looked on for a little while, admiring the "flying circle's speed;" but as she stooped to pick up a curled shaving of ivory, which she thought was too pretty to be left on the floor, her eye was caught by the words **Chinese Serpents**, printed on a drawer under the work-bench.



"Oh! sir," said she, "what are Chinese serpents; may I look at them?"

"Yes, you may open the drawer and look at them. You may take them in your hand, they will not bite you."

"Bite me! No," said Lucy, smiling, "I am not so foolish as to be afraid of their biting me. I know they are not alive."

But there ceased her boast; for starting back, after stooping over the drawer, she exclaimed, "They move, however! Harry, you may laugh; but I assure you, as I stooped down, to look at one of them, he put up his head, and looked at me; and see—there is another coiling his tail. How curious! I do not touch them, nor move any thing that touches them—here are my hands, not even near their drawer, so that I cannot have loosed any spring that could set them in motion—but perhaps opening the drawer did it."

"No; but that is not a bad guess," said Sir Rupert.

"Think again, Lucy," said Harry, "and you will find it out."

"First let me look at this conjurer," said Lucy, pointing to a painted figure of a conjurer, with a long beard, and cap, and wand, of which she saw glimpses under the serpents, at the bottom of the drawer; "May I have him out, sir?" said Lucy; "perhaps he may tell me something: I have a mind to consult him."

"Do as you please," said Sir Rupert; "but I think you had better consult your own sense."

"Yes, yes, so I will," said Lucy. "I am only in joke about the conjurer; but I just want to look at him, because, when I have satisfied my curiosity about him, I shall think better about the serpents."

As she spoke, she cautiously began to put her hand down through the midst of them, toward the bottom of the drawer, to seize hold of the conjurer, but the serpents all rearing their heads or tails immediately, she hastily withdrew her hand.

"I am afraid I shall do some mischief," said she.

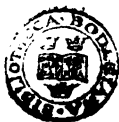
"No, my dear," said Sir Rupert, smiling, "you will do no mischief to them, and they will do none to you. There is no danger."

"Danger! Oh, no, I know that," said Lucy; "but I think Harry had better be so good as to take him out for me."

Harry plunged in his hand, and drew up the conjurer by the beard. "There he is for you," said Harry. "What good will he do you?"

"It is only a coloured print, on a paper case, now I see it in the light," said Lucy. "May I open the case, sir? there seems to be something in it."

As Sir Rupert assented, she opened it: within the case she found a yellow paper, on which were what Lucy called hieroglyphics; and inside were a number of little fish, about twice the length of the mother-of-pearl fish, which are used as counters at a card-table; but these were not of



mother-of-pearl, they were of some very thin material—thin as oiled paper, or as goldbeater's skin, and somewhat of that colour. As Lucy looked close, to see what they were made of—they began to move.

Sir Rupert took one by the tail out of the paper, and bidding Lucy hold out her hand, he laid it flat upon the palm; at first it lay still, but in a few seconds began to heave, and move its head and tail.

“Like the serpent,” said Lucy; “but how or why they move I cannot conceive, because there is no room for any spring, or any mechanism, Harry, withinside. There is no double skin. He is quite transparent; I can see through him, and there is nothing in him. How he writhes about. But what says the conjurer. What has he to do with it. Let me look at his paper, and try if I can make it out. It is not English—Copenhagen—Copenhagen!—It is Danish, then.”

“Yes; this conjurer and his fish were brought to me from Copenhagen by an officer, long ago, before they became com-

mon in this country ; and they afforded us then much amusement, trying the temperaments and fortunes, or at least the tempers and understandings of those who consulted this conjurer, and took his fish in hand. Here is an English translation of his advertisement for you, Lucy."

Lucy read, and learned that the conjurer promised to tell the temperaments, dispositions, characters, and fortunes of all manner of men, women, and children, by the aid of his fish. Mute, but not still, their motions spoke a language, which, as he boasted, could never, like the language of men, err or deceive ; and this language he, to a certain degree, and in some general points, condescended to interpret, for the advantage of all who consulted him, and purchased his hieroglyphic scroll. Opposite to the hieroglyphics, on this scroll, were the interpretations of the different motions of the fishes' heads and tails, and bodies ; also what was to be inferred from their lying still and motionless.

"Now I understand the directions ; and

let us try on ourselves," said Lucy. "Hold out your hand, Harry."

She placed one of the fish flat on his palm, and observing its motions, which were quick and sudden, floundering with his tail, she consulted her hieroglyphics, and found that Harry was "sanguine and choleric—fortunate in war."

"That is not true, I can answer for it," cried Lucy, "as far as the choleric and sanguine go. Now try *me*."

"Atrabilious and melancholious; to die of a broken heart, if not taken in time."

Lucy let fall the fish, while she laughed and exclaimed, "What nonsense!"

The fish fell into some water, which was kept in the workshop for the use of the grindstone. Recovering from her laughter, she said that he was at last in his proper element: yet he did not seem to like it, his head and tail curling up met, and he lay with only the middle of his side touching the water, as if he feared to go in.

"Put him quite in," said Harry, "and see what will happen."

Lucy pressed him down into the water, but not without his struggling; however, when he was fairly in for it, as she said, he ceased to flounder, and lay perfectly quiet.

"Now let us take him out, and dry him," said Harry, "and see what will happen."

"Harry dried one of his sides, and laid him down in the sunshine.

"Oh! the poor fish," cried Lucy; "he is just as the proverb says, as uncomfortable as a fish out of water. How he writhes about. I'll sprinkle a little water over him."

"Stay, let me dry him quite, and that will do as well, you will see," said Harry; "he will lie quietly then, though he is a fish out of water."

"Well, try," said Lucy. "Now he does lie quiet, indeed, exactly as if he were dead."

But as she stooped closer to look at him, he seemed to revive, and moved again.

"As if he felt my breath," cried Lucy.  
"Oh! Harry, I see how it is now—I know it all."

Harry smiled.

"You are right," said Sir Rupert."

"And you knew it all the while, Harry," said Lucy. "I was very stupid not to think of it before."

"You would have thought of it," said Harry, "but that you were so full of the conjuror."

"But even now I do not know all," said Lucy. "I suppose, that the motions of this fish depend on the changes from wet to dry; and that he curls and uncurls as my hair does, and for the same reason. I have not forgotten, Harry, all you and papa explained to me about the cause of curling, when one side is wet, and the other dry; when the pores are filled with moisture on one side, and not on the other. I understand that that was the case with the fish, when you dried him on one side, and left him wet on the other. But I



cannot yet guess of what substance he is made."

"Think of some of those substances of which you know hygrometers are made," said Harry.

"Old whalebone hygrometer! I remember you," said Lucy. "You smile, Harry. It is whalebone; but I never saw any before so thin."

"Very likely you never did," said Harry; "but whalebone can be scraped very thin—as thin as this you see."

"It really is whalebone, then; and I could make such a fish myself," said Lucy. "If my head had not been so full of that foolish conjuror, I might have seen all that you observed, Harry, and then I should have found it out too."

"I dare say that now you will find out what the Chinese serpents are made of," said Sir Rupert.

"They are hygrometers too, then, I suppose," said Lucy, "hey, Harry? What *can* they be made of, do you know?"

"I am not sure; but I believe I do," said Harry.

"Yes, you are right," said Sir Rupert, following the motion of Harry's eye.

Lucy turned and looked, yet she saw nothing, as she said, but dust under the work-bench; "and a box full of old iron, and brass, and hundreds of things," continued she, going towards it.

"You had better stop, and think, instead of going into that box," said Harry. "Look back at the serpents, and see what they are like. Recollect all the substances which you know would make good hygrometers, and then consider which is most like these serpents."

"Ivory!" cried Lucy. "I remember you told me that it has many pores, and that it makes a good hygrometer: they must be made of ivory. And now I know what your eye turned to—it was to that curled shaving of ivory which is lying on the floor."

Sir Rupert, after some conversation with Harry about hygrometers, asked him if he had ever seen Daniel's; and when Harry

answered that he had not, Sir Rupert exclaimed, "Let whoever is curious in hygrometers follow me to the laboratory."

Harry followed instantly, but Lucy did not : she thought she had had enough of hygrometers ; and she preferred going to divert herself with a canary bird, which she saw hanging in its cage at the window of the housekeeper's room, on the side of the court opposite to the laboratory. This bird could, as the housekeeper told her, draw up water for itself in a little bucket. She saw this bucket. It was about the size of a thimble. It hung by a delicate chain, on the outside of a sort of projecting bow window in the cage ; the upper end of the chain was fastened to the bird's foot, and the bucket lay in a small reservoir of water. The manner in which the bird drew it up was, as the housekeeper told Lucy, by taking the chain in his beak, and by placing his foot on each portion of it, as it was drawn up, till the bucket was as high as the little window, where he could drink.

He disliked, it seems, the labour of

drawing water, and never performed this operation, except when compelled by thirst. Unluckily for Lucy, just before she arrived he had drawn up a bucket full, and having satisfied his thirst, he was now singing away, loud and shrill, as if rejoicing in having cast dull care behind him. Lucy waited and waited; she and the house-keeper exhausted all their exhortations, all the endearing epithets in the language, and all their hemp seed, in vain. The canary took all the bribes as fast as they were offered, and received all the compliments seemingly in good part—but no return made he: not that he did not understand what return was expected. The rogue eyed the bucket askance, as the house-keeper held it up to him; then straight he turned his back upon her, or upon it, and sang away, pertinaciously, with a louder and a shriller note than before. A full quarter of an hour was spent upon him, then Lucy gave it up.

“What an obstinate or capricious little creature it is,” said Lucy. She then went

to ask Lady Digby whether it hurt him to draw up the bucket.

Lady Digby said she believed it did not hurt him, though she could not be certain; but she thought his unwillingness to perform the operation might be accounted for, by recollecting the pain which he had undergone in learning this feat. It is said that much cruelty is practised on birds, when young, in teaching them this and other accomplishments.

“How happy, Lucy, it is for some young birds, who are taught accomplishments without pain.”

Meantime, as soon as Sir Rupert and Harry had returned to the laboratory, Sir Rupert said, “Before I show you the new hygrometer, Harry, I must tell you, that in all those hygrometers, which are made of vegetable or animal substances, and which measure the moisture of the air by their expansion or contraction, there is one great source of error—they have no standard point by which they may be readily compared with each other. The

great De Saussure, whom you will admire still more for his candour than for his ingenuity, foresaw, and pointed out this fault in his own hair hygrometer ; and the celebrated Humboldt, who used both the hair and the whalebone hygrometers, complained that he could never make their results agree. Another philosopher calls all the ordinary hygrometers mere toys,—but without going further, it is enough for you to know, that from this cause all those instruments are found to be insufficient for making nice observations on the atmosphere. They have, besides, other imperfections : no two hairs are exactly similar in elasticity ; whalebone is not only very irregular, but very slow in its expansion ;—the wind disturbs their movements ; and dust and oil, in time, clog the pivots. Such are the principal faults of the old hygrometers.

“ Now for the new one. You have, I dare say, often observed the dewy ap-

pearance on the outside of a glass of cold water when brought into a warm room. This dewy appearance, you know, is caused by the condensation of the moisture contained in the air, and it was this circumstance that first suggested to Mr. Daniell the idea of measuring the quantity of moisture contained in the atmosphere by the degree of cold that is required to condense it; as the damper the air is, the greater will be the facility of condensation. Now by observing how many degrees cooler than the atmosphere it is necessary to make any substance before dew will be formed upon it, you can obtain the measure of the quantity of water supported in the air. This you might easily do for yourself, by trying how cold a bottle of water must be, to become dimmed with condensation. All that is necessary is to observe the different heights of two thermometers, one in the water and one in the air. It was in this manner that

Mr. Daniell tried his first experiments, till he succeeded in making the ingenious instrument which I am going to show you, in which the artificial cold necessary is produced by the rapid evaporation of ether."

He placed before Harry's eyes a brass stand and pillar, five or six inches in height; to the pillar was fixed a small thermometer, and from the top there hung a glass tube, each end of which was bent down and terminated in a ball, or globe of thin glass. One of these globes was covered with muslin, and the other contained a very delicate thermometer, the bulb of which was partly immersed in ether.

"The first thing to tell you, Harry," said Sir Rupert, "is the purpose of these two thermometers. The outside one, on the pillar, shows the temperature of the air, while the inside one marks the temperature of the ether, and therefore of the glass globe that contains it.

"Now let us place it in this open win-



dow; and when I wet the muslin covering of the empty ball with a few drops of ether, you are to observe what takes place on the other ball."

It was what is called a very dry day, and after Sir Rupert had applied the ether two or three times, Harry said that he saw a slight film of dew forming like a ring round the uncovered ball.

"*Now*, Harry," said Sir Rupert, "mark the height of both thermometers."

"You are aware," he continued, "that rapid evaporation produces cold; and that ether evaporates more rapidly than any other fluid."

Harry was partly aware of this, yet he was surprized by the instantaneous cold produced by a drop of ether that Sir Rupert let fall on the back of his hand.

"When I applied some ether to the muslin," said Sir Rupert, "the glass under it was immediately cooled, and the condensation of the vapour inside, gradually

communicated the cold to the other ball. The degree of cold there is shown by the inside thermometer, and the *difference* between that and the temperature of the external air, at the moment the dew is deposited on the glass, is the measure we want of the moisture suspended in the atmosphere."

"Then I suppose, sir," said Harry, "the drier the air, the greater is the difference between the thermometers."

"You are right, Harry. If there had been a large proportion of moisture in the air, a very small additional degree of cold would have been necessary to condense it, and you would have seen the film of dew immediately follow the application of the ether to the covered ball. On the contrary, when the air is very dry, a considerable increase of cold is requisite, as you have found to be the case to-day; the inside thermometer having fallen fifteen degrees before the dew was deposited on the ball."

After this explanation, for which Harry was very thankful, Sir Rupert advised him to look at the inventor's own description of the instrument in the Quarterly Journal of Science, No. 16.

"But first," said Sir Rupert, "let us go out, if you please, this fine day, and have some exercise and some amusement. Remember the bow must not be always bent. By the bye, here are bows and arrows, and here is a little bow, which Edward had when he was your age, which will just suit your sister Lucy. Call her, and bring her out with you to the bowling-green: I will have the target set up for you."

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"An hour and a half! is it possible," said Lucy, "that we have been really an hour and a half here on this bowling-green?"

"Exactly an hour and a half since first I fixed an arrow in that bow, and settled

it in your hand," said Harry; "for I happened to look at the sun-dial just as I went back to my place."

"We have been so very happy!" said Lucy, stretching out her arm to rest it.

"But now you seem to be rather tired of your happiness," said her father, "and you had better stop before pleasure turns into pain."

"My arm only is tired, papa," said Lucy; "I am not the least tired myself. However, I think we have had enough for to-day, and we can come back to it to-morrow, if to-morrow should be as fine as to-day."

"In the mean time come with me to the house," said Sir Rupert. "This way leads towards the old part of the castle; I will turn you into a cool armoury to rest yourselves, and where perhaps you may find fresh amusement in looking at the bows and arrows of former times."

They followed joyfully to the armoury:

he showed them in the first place a bow and arrows, which had remained in this castle—family tradition failed to tell how long ; but certainly since the days of our Henrys and Edwards, when bowmen and archers flourished, and when bows and arrows were not, as now, taken up as matters of amusement, by fine gentlemen and ladies, to win prizes at festive meetings, but employed as serious weapons in battles and sieges. Sir Rupert was going on to show Harry the cross-bow, such as was in use and repute among our ancestors ; but Lucy's eye was caught by an Indian bow and arrow, and he turned to take it down for her. It was stiff with rings of dried thongs of leather, which had been put on the bow to commemorate each savage victory obtained by the owner. Next to this Indian bow there hung another, said to have been brought from Mexico, at the time when those poor people, or, unhappily for them, those too rich

people, were invaded by the avaricious Cortes, and when their bows and arrows so ill defended them against the fire-arms of the Spaniards. Harry and Lucy regretted the fate of the inoffensive Mexicans, and wished that they had been possessed of the ingenious invention of fire-arms for their just defence.

Sir Rupert went back to the cross-bow, and showed Harry how it was constructed and used. The stock was made of wood, neatly inlaid with bone, and ornamented with tassels; but the bow was of steel, and so stiff, that Harry's utmost efforts could scarcely bend it. Sir Rupert told him that no person had sufficient strength to draw back the string into its place, without some mechanical assistance, and desired him to examine the bow carefully. Harry observed a long iron lever, the end of which turned upon a pin in the middle of the stock. To this lever a little jointed arm was attached, which termi

nated in a kind of hook, that seemed to invite the string: he slipped the string over the hook, and pulling round the outer end of the lever down to the butt end of the stock, he easily accomplished the bending of the bow. Sir Rupert then showed them the trigger, or *serpentine*, as he said it was formerly called, by which the string was released, and the arrow or ball projected.

Harry was surprised to hear him mention balls; still more, when he was told that balls both of lead and stone were used. Sir Rupert showed them also various kinds of darts and arrows, one of which, to Lucy's great amusement, he called a *quarrel*; he explained to her, however, that the term was derived from the old French word *quarreau*, on account of its *square* head of iron. Cross-bows and quarrels, Sir Rupert added, were much used in the time of Henry the Second. They were of great effect in

his wars in Ireland, and assisted much in his conquest of the Irish, who possessed no such weapons.

In this armoury were many of the warlike instruments and armour used in ancient times by the English. Sir Rupert showed Harry the *helmet*, the *vizor*, and the *lance*; and explained to him how the lance stood in the *rest*, when the knight was on horseback; and he showed him all the parts of the knight's armour, with which he cased himself and his horse in iron, so that, as long as he and his steed could hold together, they were almost invulnerable, till the lance was wrested from his hand, or his foot *ousted* from the stirrup. The united weight of man and horse, or their joint momentum, was of great consequence, as the heavier they were, the greater the shock with which they came against their adversary, horse to horse, and man to man. Harry and Lucy were glad to know the exact ap-



pearance of all these things, of which they had read in history, as being used not only in battles, but in the *justs* and *tournaments* of former days.

Lucy enjoyed them from the recollection they brought to her mind of many passages in poetry, and from the pleasure she always felt in whatever filled her imagination.

Harry's mechanical taste was gratified by examining the ancient coat of mail, or *hauberk*, consisting of small steel rings, linked together, or interwoven, in the manner that some ingenious purses of steel rings are made at this day.

After Harry had satisfied his curiosity, Sir Rupert took him on to those later inventions, which made of no avail "helm and hauberk's twisted mail." He showed him some of the first rude attempts at fire-arms; the *arquebuse*, or long gun, described by Froissart, used with a rest, upon which it was supported, and with a sort of

shelter-piece to protect the match from wet and wind. Between this first clumsy attempt to execute that grand invention, and the perfected Manton's and Forsyth's guns of our own times, various improvements were made, some of which Sir Rupert explained to Harry. Lucy, whose curiosity was not only satisfied, but satiated, went off to seek for amusement and information more interesting to her, in the garden and the conservatory, with her mother and Lady Digby. Indefatigably kind Sir Rupert ended by finding "Froissart" for Harry in the library, and unfolding for him those delightfully entertaining old prints, where the battles of Poitiers and Cressy are represented so happily, though in defiance of all the laws of perspective.

After speaking of the wonderful change which the introduction of fire-arms produced in the world, and of the astonishment which their first appearance created among civilized and uncivilized nations in Europe and America, Sir Rupert related to Harry an account, which he had just read in a new book of travels, of a people

by whom the power of fire-arms has been even recently defied.

“Between the Nile and the desert,” said Sir Rupert, “there is a narrow strip of cultivated land, which in some places is not more than half a mile in breadth, but which stretches hundreds of miles in length. This strip of land was inhabited by various independent tribes, till within the last three or four years, when a despotic Turkish Pasha, of the name of Mahommed Ali, resolved to send a large army, under the command of his son Ismael, to subdue them. Ismael’s progress was unresisted, till he came to one warlike tribe, who, with equal courage and patriotism, defied the invader. ‘He may drive us to the gates of the world, but we will never submit,’ was the answer they sent to his threats.”

“Brave people!” cried Harry. “I hope they drove him back again.”

“They were heard shouting from their encampment,” continued Sir Rupert, “‘You may come against us from the north, and

from the east, and from the west, but we will never submit.' They knew that the Pacha had fire-arms—they had none—but they put their trust in the weapons and shields to which they had been accustomed, and in their own courage. Their shields of hippopotamus, or of crocodile skin, covered the head and the breast. Their weapons were swords and lances: and their sorcerers assured them, that their shields and themselves should be rendered by magic invulnerable to musquet balls.

"Bravely they came out to give him battle, and advanced boldly at first; but when the volleys of musquetry began to play, and when they found, that in spite of their promised invulnerability many fell wounded and killed, a panic seized them, and they fled. After this first defeat, however, they entrenched themselves in their mountains; their courage revived, and again they sent forth shouts of defiance, bidding the Pacha 'to come if he dared.'

"But Ismael had learned to respect their bravery: he had once already been sur-

prised, and almost defeated by the black horsemen of the desert, and he therefore prudently resolved to attack them with a heavy fire of shot and shells. One of these shells fell amongst them; and as it was rolling and bounding along, these poor ignorant people gathered round it, admiring and amused by its motions; but when it burst, and spread destruction round it, they cried out, 'The evil spirits are come against us, and are too mighty for us.' The superstition, that had at first given them confidence, now only increased their despair; and, abandoning their strong holds, they set off in full flight, their patriotism expiring with their liberties. Afterwards they bargained for their wretched lives; and were contented to join, as his soldier slaves, the army of their conqueror."

As Sir Rupert concluded, Harry groaned. "Was this," said he, "the end of their glorious 'You may drive us to the gates of the world, but we will never submit?'"

"Even so, Harry; so little dependence can there be on mere animal ignorant

courage, that braves the danger of which it does not know the nature or extent."

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THE glass doors at one end of the library, leading into the conservatory, were half open; and now that Harry's attention was no longer engaged, he observed a gale of fragrance, like the smell of fresh hay, or of that grass which gives to fresh hay its pleasant odour (*anthoxanthum odoratum*). A second waft, however, decided that it was from Lady Digby's favourite plant, the heliotrope, innumerable pots of which the skilful old gardener contrived to force into premature flower and perfume, so as to have a constant succession for her ladyship's conservatory. He heard Lucy's voice too; and though he was not, as he used to say of himself, a great green-house merchant, he now went in there, and found Lady Digby showing some plants, which had been lately sent to her from North Carolina by a kind American lady. There

was one which is rather uncommon in these countries, as it is so delicate, that without care it seldom survives a winter in our climates. It is something of the nature of the sensitive plant; the inside of the leaf is thickly set with bristly hairs, like thorns, or like many little sharp teeth. As soon as Lucy saw this plant, she took up a straw, and drew it along the division, or middle rib of one of its leaves, and immediately the two sides of the leaf folded up, and the prickly teeth closed together, so as to hold fast the straw.

“ I see it is the plant I thought of,” said Lucy. “ Venus’s fly-trap, is not it?”

“ Yes, *dionæa muscipula*,” said Lady Digby; “ have you seen one before?”

No; Lucy had never seen one, but she knew it, she said, from having read a description of it. The gardener by this time had caught a fly, of which he had been in search on the window for some time—for flies were few and rare at this season—and holding his struggling prisoner by the two wings, he was going to

set him upon one of the leaves, that the young lady, as he said, might see what would happen; but Lucy stopped his hand—she knew what would happen—that the moment the fly touched the leaf, the teeth would close upon it, as they had closed on the straw, and squeeze it to death. The old gardener immediately complied with Lucy's entreaties to release the poor fly; and Lucy observed to him, that there was the less occasion for this experiment, as the many dead flies showed how well some of the leaves had performed their cruel office. "But I really think," she said, "that those fly-killing leaves are larger and greener than the rest."

The gardener answered, that he had often remarked the same thing; and though some folk said that they were fattened and nourished by the dead flies, for his part he thought it just as likely that it was because the healthy and vigorous leaves had a greater power of shutting close and crushing the flies. "But," added he, with



due philosophic caution, "I can't take upon me to decide."

Harry admired the ingenious mechanical structure of this fly-trap, and began to say, that it reminded him of something which he had seen elsewhere; when Lucy smiled, and said, "I know what you are going to say, Harry, and you are quite right: you mean the plant called the fly-catcher; a sort of *arnut*, which smells, as you said, Harry, like a dead horse. And there is another plant, in which mamma showed me the same sort of contrivance," continued Lucy; "but I cannot recollect its long Latin name. I remember that papa lent me a magnifying glass to look at the dead flies lying at the bottom of its flowers: some were held by the proboscis, and some by the legs. This plant is called in English, I believe, *dog's-bane*. Was not this what you were thinking of, Harry?"

"No, I was not thinking of any plant," said Harry; "I was thinking of a machine;

a sort of trap, which catches rats in the manner that this catches flies."

Lucy was a little scandalized by this inelegant comparison.

"The fly-trap of Venus compared to a rat-trap!" But on Harry's appeal to his father, it was allowed to be just, as far as mechanics go.

The gardener thought it was now his turn to get in a few words in praise of the strength and healthiness of his *dionæa*. It had been sent over from Carolina in sods of its native earth, which still remained in a box to which he pointed. "There were more plants in it," said he; "but they have died; so I shall empty out the sods now, for they are a disfigurement here."

Harry said it would be a pity to throw this earth away; for he recollected having heard, that when the boxes of plants, which Peyrouse, in his voyage round the world, sent home to France, were opened, the plants and shrubs in some were dead, yet the gardener did not throw away the

earth, but preserved it carefully, because he thought it might contain the seeds of some sorts of plants unknown, perhaps, in these countries ; and so it proved.

Lady Digby, upon hearing this circumstance, desired her gardener to put the American earth into small pots, and to place them in a hot bed. " If it should produce any plants that are worth your acceptance, Harry," said she, " you, to whom I shall owe them, shall share them with me."

" Mayhap, master, you might not know what this is," said the gardener, opening another little box, and putting into his hands a small bundle of what seemed to Harry to be black horse-hair.

" Is it horse-hair ?" said Harry.

" It is horse-hair," said Lucy.

" No, miss—no, master ; though I took it myself for that at first unpacking."

Lucy pulled a bit of it out ; and after feeling, said, " it feels like horse-hair, crisp, and springy ; and it looks so like it, that I can hardly believe it is not horse-hair."

"Never was on a horse's back, miss, nor ever belonged to any animal."

"Is it animal or vegetable?" said Lucy.

That was soon settled, by Harry's running back to the library, and burning a bit of it; the remains he held to Lucy's nose, and its smell convinced her of that which her eyes had failed to discover, that it was neither horse-hair, nor any animal substance. "Then it is a vegetable. What can it be?"

"And what do you think this can be, miss!" said the gardener, putting into her hand another little bundle of something, which Harry said looked like ends of white coarse thread, such as he had seen in a taylor's shop, and which he had heard called *thrums*. Lucy agreed that it was like tangled housewife's thread; but on a nearer view, she, who was more knowing in housewifery than Harry, pronounced that it certainly was not thread. Looking at what Harry drew out, and called a needle-full, she observed sundry little short filaments, or stalks, and at the end of some of

them were little knobs, which, on further examination, were evidently the remains of very small flowers: she pronounced it therefore to be a vegetable; and she was surprised to hear, that both this, and what she had called black horse-hair, were one and the same thing, only in different states.

“I will, if you please,” said Lady Digby, “read to you the account that I received from the American friend, who sent them to me.”

She returned to the library to look for the letter in her writing-desk; and Harry and Lucy stuck close to her, much afraid that the letter might not be forthcoming; but she found it, and read as follows:—

“‘The foliage of several trees here,’ (near Wilmington, in North Carolina) ‘has, in some situations, a singular appearance. A sort of long grey moss suspends itself from the branches, and, waving in the wind, gives the trees a hoary, and to me not uninteresting appearance. When stripped of its external coat, this moss nearly resembles horse-hair. It is col-

lected for that purpose in large quantities, and buried in marshy spots; and when the outer coat peels off, the inner part is dried and cleaned, and makes excellent mattresses.’”

Lucy’s mother observed, that the outer coat of flax is destroyed in the same way, by steeping it in water.

Lucy inquired whether this kind of horse-hair moss, as she called it, had any name; and whether it was known in England, or was a new discovery. Sir Rupert Digby told her, that though he had never before seen this extraordinarily fibrous *species*, yet he was aware that the *genus*, or family of plants to which it belonged, had been well known to Linnæus, who had given it a singular name, from a singular circumstance.

“It will make me remember the singular name,” said Lucy, “if you will be so good as to tell me the singular circumstance.”

“You must know then,” said Sir Rupert, “that among the early botanists of Sweden,

there was a certain doctor, who, having in his youth had an unfavourable voyage by water from Abo, where he lived, to Stockholm, made a vow, the moment he set his foot on dry land, that he would never again venture himself upon the sea. He kept this vow so scrupulously, that when he was to return home, he took a roundabout journey of several hundred miles, to avoid a passage of a few hours by water. His hatred of water, and his love of the dry land, rose to such a pitch, that he laid aside his family name to take that of *Til-lands*, which in Swedish means *on land*. You think, perhaps, and so do I, that this doctor made a rash vow, and did not in all this show much sense. But a man may be weak in some things, and wise in others. He was wise in botany, and made an excellent catalogue of all the wild plants in the neighbourhood of his residence; in honour of which, and of the whimsical name he had adopted, Linnæus gave the name of *Tillandsia* to this genus of plants, as they are remarkable for their dislike of

water. Lucy, do you think you will now be able to remember the name *Tillandsia*?"

"I think—I am sure I shall," said Lucy.

Sir Rupert further told Lucy, that one of the most severe censors of Linnæus had been so much pleased with the happy choice of this name, that he declared he would excuse in Linnæus a thousand faults for that fact alone.

Lady Digby said, her American friend had been so obliging as to send many other curious things in the box, besides the specimen of this moss. "Among others, I am sure, Lucy, you will like to see some pods of cotton, in their different stages of ripening. My friend tells me, that they grow on a bush from two to four feet high, and that the flower is of a delicate straw colour. I dare say you may have seen an engraving of it."

"I think I have," said Lucy. "But oh! Lady Digby, before you shut the box, will you give me leave to look at that green leaf—if it is a leaf?"



"You do well to say, if it is a leaf," answered Lady Digby. "Do you know what it is?"

"Is it the *creeping leaf*?" said Lucy.

"No," answered Lady Digby. "It much resembles the creeping-leaf, or *mantis strumaria*; but this is a different insect: by the country people in America it is called the *catydid*, from the sound of its chirping resembling the frequent repetition of Catydid! Catydid!"

Lucy examined this insect more closely. It was about the size of a rose-leaf, of the pale green colour of the inside of a pea pod, and apparently of that smooth texture: but upon looking at it with a magnifying glass, Lucy saw, that what had appeared like the veins of a leaf, were the ribs or sinews of the wings; and in the intermediate spaces, which had, to the naked eye, appeared perfectly smooth, she now saw, embossed, innumerable little spots, looking like shagreen.

"Now I see the animal's head, where the footstalk of the leaf seemed to be, and

its eyes, nose, and mouth," cried Lucy. "Pray look, Harry! Its head and face are like a horse's head and face in body clothes;—look at its protuberant bladder-looking eye; the mouth, however, is like a pig's, or the ant-bear's, and round its neck it has a curious worked pelerine, standing up like the leather *hood* on the collar of a waggon horse. But what curious thing is that lying loose in the box, with its green long-jointed stork-like legs? What do they belong to?"

Before her question could be answered, her rambling eye fixed with delight and curiosity on a plant which hung flaunting from the top of the conservatory; she asked where its roots were, how it was nourished, or whether it lived on air?

Lady Digby answered, that it was reputed to live on air, as its name of *flos aëris*, or the air-plant, shows, and that probably it derives its nourishment from the moisture in the air. "However this may be in its native country, it thrives much better here, if planted in a little light earth, or

even in wet moss, as you may perceive, by comparing it with the other specimens which you see twined round that pillar, and which are all planted in pots. This plant, nevertheless, has been hanging, where you see it, for four months; and though it requires a much greater heat, it is quite alive. It is frequently watered, and I want to try how long it will live in that situation. But," continued Lady Digby, "if you, my dear Lucy, who are so active and obliging, will run up stairs to the little turret, within my room, you will find a book, with many paper marks in it, on my desk: bring it down to me, and it will tell you something more about this curious plant."

Lucy vanished, and re-appeared, bearing in her hand the proof of her swift errand.

"This is a favourite book of mine and of my son Edward's. All these marks he put in for my edification. I was no botanist, but he and this little volume together have made me fond of what appears to me the most interesting and rational part of the

study—that which opens to our view the curious and useful structure of plants, and the progress of vegetation. I like this book for another reason,” continued Lady Digby, turning to Lucy’s mother, “which makes me rejoice that it pleases young people. Without any ostentation of religious sentiment, it really inspires it in the best and happiest manner. Here is the account of the *flos aëris*,” continued Lady Digby. “Will you read it to us? It is very short.”

Lucy read :—“ ‘ There is one species of the *epidendrum* family, the *flos aëris*, a native of India, that deserves to be particularly distinguished. It is so called, because it grows and blossoms when suspended in the air; and we are assured, that hanging from the ceiling of a room, it will vegetate for years; it is likewise said to be remarkably reviving to the inhabitants, by the fine odour of its blossoms.’ ”

“ That fact,” said Lucy’s father, “ of its hanging from the ceiling of a room, and

vegetating for a length of time in that manner, is mentioned, if I recollect rightly, in one of Sir William Jones's letters, written when he was in India. He says, the *flos aëris* was at that instant suspended over his head; that he had tied its rootless branches to the beams of the roof, and he speaks with delight of the charming fragrance of the blossoms."

"And now," said Sir Rupert, "pray may I ask—I have been very patient while you ladies have had the book to yourselves, with three pairs of hands upon it at once—may I ask the name of this favourite book, if name it have; for hitherto I have heard it called only *it*, or *the* book, or *my favourite* book—has it a name?"

"It has a name," answered Lady Digby, "and a name that will be well known to fame in due time. 'Dialogues on Botany.'"

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NEXT morning, after breakfast, an express came from the housekeeper's room to in-

form Lucy, that the canary-bird was beginning to draw up his bucket. Down stairs she ran immediately, and after her followed Harry.

The thirsty little fellow now working for his own interest, and with his own good will, soon performed his task, and earned his thimble-full duly raised. When lifted to the proper height, he held it, by keeping the collected chain fast under one foot. Then he dipped, shook his beak, and dipped and shook again, much to his own delight, and to that of the spectators. When he had fully satisfied his thirst he began to favour the company with a song ; but his notes, even when joy tuned his throat, were so loud and shrill, that his mistress, the housekeeper, soon threw a white handkerchief over the top of his cage to reduce him to silence, so that, as she said, " she might hear somebody speak besides him."

Lady Digby, who had followed Lucy to see her friend the canary-bird perform its little exercises, confirmed Lucy's hopes,

that birds may be taught by gentle methods, when young, many of those feats which are generally acquired by the infliction of so many tortures. She had when abroad, as she told Lucy, known a German music-master, who was very fond of birds, and who was most expert in teaching them. He assured her, that he had himself instructed a bullfinch, which he would venture to say was as accomplished as any of its kind in all Germany, where these birds are chiefly born and bred ; and he had never used hot knitting needle, or any other instrument of torture in its education—only soft words, and sometimes, he acknowledged, a little wholesome fasting. Lady Digby recollected that this judicious bird-fancier, or bird-instructor, further told her, that he always taught his pupil at the dead still hour of midnight, or when all the rest of the family were asleep, and when there was nothing to distract the bird's attention. Then he would play tunes for him on the violin. The bullfinch seemed to take no notice,

and never attempted at the time to follow him, but the next day he would practise by himself, and at last bring out the tune he had heard at night."

Lucy's attention was now called off to a basket of lavender, which a maid at this instant brought into the room. The house-keeper was going to make her annual store of lavender-water: the *still* was ready, and Lucy wished to see the operation of distilling; but Harry whispered his advice to her, to wait and see it performed in the laboratory. Looking out of the window to the other side of the court, he observed that the iron door was open, which was a sign that Sir Rupert was in the laboratory; and on this hint Lucy immediately ran there with Harry, and found Sir Rupert and their father.

Fortunately for Lucy, Sir Rupert wanted, for the experiment he was then trying, to have some water that should be perfectly pure; that is, quite free from all mixture of earth, or salts, or other substances; and for which purpose it was to be distilled.



This was a simple process, which Lucy could understand. Sir Rupert had just prepared his *alembic*, the apparatus usually employed in distillation for chemical purposes. It was a pear-shaped glass vessel, into which the liquor to be distilled was put; a lamp was placed underneath, by the heat of which the liquor was made to boil, and the vapour that rose was condensed in the cover, which was a conical-shaped cap of metal, with a *beak*, or spout, that sloped downwards into another vessel, called the *receiver*.

"These drops," said Sir Rupert, "which you see running off from the beak, are collected in the receiver; and the liquor thus collected is said to be distilled. All distillation is performed upon this principle, though the apparatus is different for different purposes, and sometimes made of copper."

"I have heard of a *worm* used in a still, what is that?" said Lucy.

"The worm is a spiral tube, so called from its resembling the form of a worm;

its use, in the still, is the same as that of the cap over this alembic, to condense the hot vapour."

Lucy asked why the worm was used instead of the cap?

"Because," said Sir Rupert, "it exposes more cold surface to the vapour. Suppose the whole pipe to be unwound and laid open, you would then perceive what a large surface there would be. Besides which, the colder the worm is kept the quicker the condensation proceeds; and a worm, or a long pipe coiled up, is very conveniently placed in a vessel of cold water, which may be changed whenever it becomes warmed by the hot vapour that communicates its heat to the metal worm."

"I understand it now, thank you, sir," said Lucy.

She perceived, that in fact, though the apparatus was different, the thing done was no more than what she had formerly seen when she was six years old, when the

cold plate was held over the vapour of boiling water, that issued from the top of the tea urn. She recollected something of the account of distillation and sublimation in "Conversations on Chemistry," and searching for the book in the library she refreshed her memory by reading the passages over again at this moment, when she had the advantage of seeing the real things, and perhaps of seeing the experiments tried.

She there found that *sublimation* is the name given to the process of distillation, when applied to solid substances.

"Sublimation—a sand-bath—flowers of sulphur," she repeated, wishing earnestly that she could see all these things.

Sir Rupert said, that as the sand-bath was now heated over his little stove, for his own experiments, he could easily gratify her curiosity. If she pleased he would, however, instead of flowers of sulphur, let her see flowers of *benzoin*.

He put into her hand a small lump of

a brownish substance, which he told her was benzoin: and that it was a *resin*, or more properly a *balsam*, obtained from certain trees which grow in the East Indies, chiefly in the island of Sumatra. From this substance flowers of benzoin are obtained by sublimation, in the same manner as flowers of sulphur are produced. Lucy watched the process.

The benzoin was put into the glass alembic, which was placed in the sand-bath; and this she saw was merely a cast-iron vessel, containing a quantity of sand. Sir Rupert explained to her, that the heat was more uniform, and could be better regulated by means of the hot sand, and that there was less danger to the glass, than if it were exposed to the direct heat of the fire. He told her also, that chemists make much use of a bath of boiling water; and that in some arts, tempering certain kinds of springs for instance, workmen use baths of melted lead, or tin, or some other fusible substance, because the exact temperature at which these metals melt

being known, the proper heat may be applied with the greatest precision.

In a short time the benzoin began to swell; the resinous parts, and other impurities with which it had been combined, remained at the bottom of the alembic, but the volatile parts flew off, and were condensed by the cold cap. These were the flowers, and were different from what Lucy expected to see. They were more like flakes of snow, than any thing else to which she could compare them. While she was looking at them, Harry ran out into the yard to the gardener's boy, whom he saw coming in from the garden, with a basket of herbs on his arm. From his basket Harry plucked a sprig of rosemary, and returning without letting Lucy see what he had in his hand, he sprinkled it over with flowers of benzoin, and then held it before her eyes.

"It looks exactly as if it were covered with hoar frost!" cried Lucy. "How beautiful! I shall never forget this, Harry. But here are the horses coming out for

Sir Rupert and papa to ride, and so there is an end of all things—at least in the laboratory, for this day.”

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BATTLEDORE and shuttlecock was kept up one rainy morning by Harry and Lucy—believe it who may, boast as much who can, two thousand three hundred and twenty-four times. They had also many a game of nine-pins in the great hall, where, prolonged by its echoes, was often heard the heart's light laugh, at the fall of the merry men all.

But all these the promised joys of Digby Castle, each proving greater in the enjoyment than the promise, were exceeded by the delights of the workshop and laboratory. Every morning they watched for the moment when Sir Rupert moved towards the iron door: Avicena never watched more anxiously the famous library door, that opened but once a year.

One morning Lucy observed a shallow

drawer on the table between her father and Sir Rupert, and in this she saw some things, which she thought might be very useful to Harry. The drawer contained many lenses of telescopes, and glasses of different sizes; some as large as that of Harry's camera obscura, which had been so unfortunately broken. It occurred to Lucy, that the loss might now be repaired. She waited till Sir Rupert was not busy, and then she asked him whether these glasses were very precious, too precious to part with, or whether she might beg one for Harry? Sir Rupert said that they were precious to him, because he was repeating some beautiful experiments of Dr. Brewster's and Mr. Herschel's, on the magnifying powers of telescopes; but he desired to know which Lucy wished for, as possibly that one might be spared.

She looked at the variety that lay before her, but which of them she wanted she could not tell. It was in vain to consult her father's eye: it never moved. Sir

Rupert stood by with his good-natured smile, waiting her decision, but without giving any direction to her choice.

“ If I could but recollect exactly the shape of the old glass in Harry’s camera obscura,” said Lucy. “ What I want is a glass that magnifies ; of that I am sure. These which are convex magnify, I believe. But,” continued she, “ after having looked through several of them at a word which was written in small characters on the front of the drawer, “ I find that some of these glasses magnify much more than others ; and another thing I perceive, that, as I move each glass nearer or further, there is one particular distance at which the object appears distinct, but that the distances are quite different for different glasses. I recollect hearing you, papa, telling Harry something about the *focal distance*. But I had better not say any thing about that, as I do not understand it. I cannot tell which of these convex glasses will suit the camera obscura.



However, I know the sort that I want should be convex."

"Very well, my dear," said Sir Rupert; "that is indeed all that you can tell, or that can be known without trial. You shall therefore take several of these convex lenses home with you, and Harry, by trial, can determine which will best answer your purpose."

Lucy was very much obliged to Sir Rupert, and delighted, that through her means her brother's camera obscura was likely to be mended. But now that her curiosity was excited she wished to know more.

"Why, papa, do convex glasses magnify, and concave glasses diminish? I wish I knew. I wish I could understand the camera obscura. Mamma says, that *camera obscura* is Italian for dark chamber."

"So far so good for the name," said her father; "but in this case the name tells us nothing of the nature of the thing."

“ Yet, papa,” said Lucy, “ the first time you showed Harry and me a camera obscura, it was in a large dark room.”

“ Was it quite dark ?” said her father.

“ Not quite : the shutters were all closed, but there was a little hole in one of them, through which the rays of light came. We saw images of things very faintly upon a white sheet, which you had hung up opposite to the hole. What we saw was a sort of coloured shadowy picture of the landscape that was outside of the window ; and I remember that all the images were upside down.”

“ True,” said her father. “ You observed that it was very faint and indistinct ; did it remain so ?”

“ Oh no, papa ; it became afterwards quite distinct, and almost as bright as the natural colours of the trees and grass, and we saw the figures of people as they walked past, in a field at a little distance from the window. I saw the colour of the women’s red cloaks, and their faces

quite plainly ; and the figures were not upside down, as before."

" And what made these differences ?" asked her father.

" It was a glass, a lens you called it, which you put into that hole in the window-shutter ; just the same way as the glass makes the landscape appear brighter on the paper, in Harry's portable camera obscura."

" Do you recollect how or why the lens produced this effect ?" said her father.

" No, papa, not exactly. Harry explained to me afterwards something about it, but he could not tell me all ; he said he did not know all then."

" All ! no, indeed," said Harry ; " not then, nor now."

" Tell us all you remember, if you remember any thing of what he did explain," said her father.

" First he told me," said Lucy, " why we see the shapes and colours of things. He said it was by the rays of light which come from them."

“ Come from them how ? ” said her father ; “ do you mean come out of them ? ”

“ No, papa : but the rays of light go from the sun and strike upon objects, and then come from them to our eyes ; or, as people express it, are *reflected* by those objects. Harry next told me something which I thought I understood at the time, but I am not sure that I can explain it.”

“ Try,” said Sir Rupert.

“ Harry showed me, in a book, an engraving of an eye, with lines representing the rays of light coming from all parts of an object, and meeting in an angle at the eye. He told me, that objects appear to us great or small, according to the size of that angle. Next he told me, that our eye is in some way like a camera obscura. There is a little hole in the middle, through which the rays of light pass, as they passed through the little hole in the window-shutter into the dark room ; and after having crossed each other, they make a small picture of the object—I do not

know where exactly, somewhere at the back of the eye, I believe, and upside down, as we saw the objects at first on the white sheet; but in the eye these pictures must be extremely small. Something more Harry said about a part of the eye, which he called the *crystalline humour*; and about the rays of light being bent as they pass through it, which I think he called being *refracted*, but which I did not understand at all."

Sir Rupert observed, that Lucy did well not to attempt to go farther than she knew clearly. There is hope, he said, of teaching any thing to those who perceive and acknowledge when they do not clearly understand, and who are not satisfied with confused notions. Lucy was glad to hear Sir Rupert say to Harry, that his little pupil did him credit; and that she was not like little conceited misses, who, instead of wishing to learn in order to improve, desire only to display a smattering of knowledge."

"I am glad, my dear Lucy," added her

father, "that your curiosity has been raised on these subjects. But we cannot, at present, assist you further. Only keep what you have steadily in your mind, and from that you may 'go on hereafter. With Harry's help, assisted by his favourite book, 'Scientific Dialogues,' and with your own attention, you may learn what you desire, but not all at once. You must not expect to learn Optics in one morning."

END OF VOL. III.

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